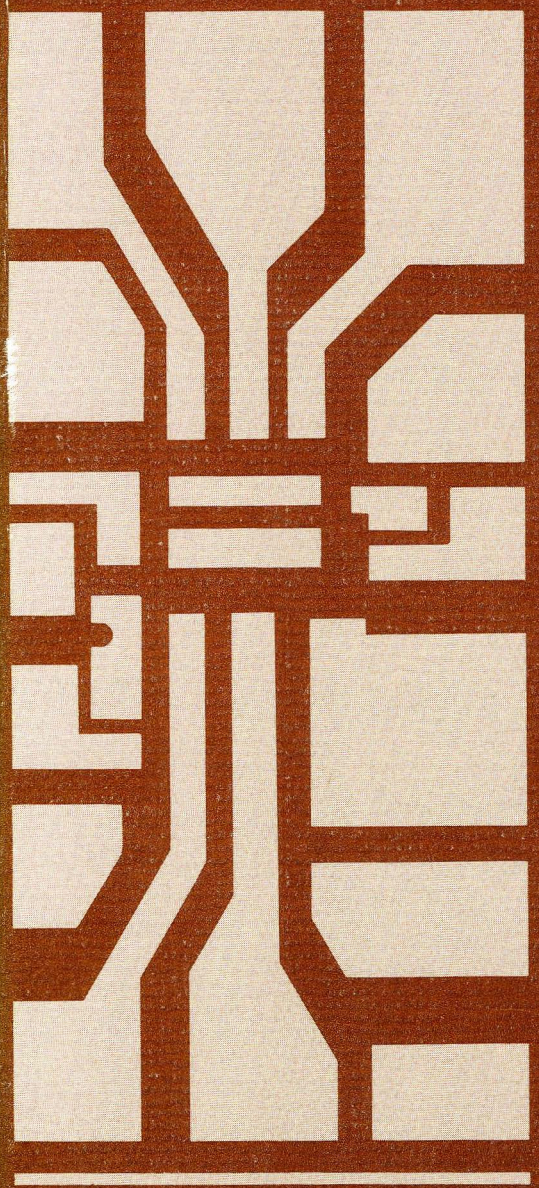
IC 1977 MASTER



- **FIVE MASTER SELECTION GUIDES**
  84 companies' IC's organized by type, function, key parameters
- **OVER 1000 PAGES OF TECHNICAL INFORMATION**
  Provided directly by manufacturers covering 17,000 IC's
- **ALTERNATE SOURCE DIRECTORY**
  The only industry-wide, pin-for-pin version available
- **MILITARY PARTS INDEX AND CROSS REFERENCE CHART**
  Identifies all IC's with JAN qualification
- **MILITARY DEVICE TESTING TABLE**
  List companies that screen to Mil. Std. 883
- **MILITARY PARTS INDEX**
  The first functional guide to JAN qualified parts
- **PART NUMBER INDEX**
  Parts from 84 manufacturers, in numerical sequence
- **APPLICATION NOTE DIRECTORY**
  Digest of currently active application note material
- **PRODUCT INDEX**
  Provides alphanumeric listing of 84 manufacturers' lines
- **PART NUMBER GUIDE**
  Instantly decodes each company's part numbering system
- **MANUFACTURERS AND DISTRIBUTORS DIRECTORY**

IC 1977 MASTER

THE FIRST STEP

IC MASTER is the **first** and **only** complete guide to Integrated Circuits. Now you can turn to the one source that has become the first step in the critical selection of Integrated circuits. Whether an IC exists in new design or is one of thousands, you'll find it out in seconds by using the MASTER. . . .

TIME

The IC MASTER saves you time and lots of it . . . no longer do you have to spend long tedious hours and days searching through manufacturer's catalogs and data sheets for information. The MASTER gives you — at your fingertips — an easy way to narrow your IC choices quickly, accurately and systematically with the knowledge that you have just surveyed the entire industry.

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A quick guide to your IC MASTER

PART NUMBER INDEX This revolutionary index takes all device types made by 84 IC manufacturers and arranges them in numerical sequence excluding prefixes or suffixes. You can now find a device number even though you do not know either the full part number or even the manufacturer. Once a basic device number is located in the index, you can obtain instant identification of all manufacturers making a device by that number and determine the full part number designation. All page references to data sheet material and any existing application notes abstracts are also provided.

PART NUMBER GUIDE An instant decoding kit. Information in this guide, provided by the manufacturers, allows you to break each company's part numbering system down into product temperature ranges, packaging variations, and functions. An invaluable tool for the elimination of costly and time consuming ordering errors caused by lack of standardization in part numbering systems.

APPLICATION NOTE DIRECTORY To prepare this directory each IC manufacturer reviewed his own application note inventory and identified all those application notes considered to be currently active. Thus, in addition to providing a directory of active application note abstracts, the IC MASTER directory also provides the first industry wide purge of obsolete material. Application note descriptions are arranged by Digital, Interface, Linear, Memory, and Microprocessor categories. Beneath those headings, material is arranged alphabetically by function and applications category. Each application note is listed by title, identifies the specific device featured, provides a 25 to 50 word abstract, and includes identity of both the authoring manufacturer and the specific application note number. This section provides all the information necessary for the engineer to update his application note files speedily or thoroughly research the existance of application note material for a specific design problem.

MILITARY PARTS DIRECTORY Cross Reference Chart identifies all IC devices having received JAN qualification. This chart includes a cross reference feature converting device numbers to Mil. Std. 38510 slash number and vice versa.

MILITARY DEVICE TESTING TABLE Lists 40 major IC manufacturers and shows, in matrix form, those device types tested to Mil. Std. 38510 as well as screening performed to Mil. Std. 883. Those companies willing to perform special screening to customer's unique military requirements are also identified.

MILITARY PARTS INDEX A "first ever" functional guide to JAN qualified parts. Now it is possible to search by device and function to determine whether a JAN qualified part exists for your application, and if so, obtain both the device and 38510 slash numbers.

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ALTERNATE SOURCE DIRECTORY The first industry-wide, pin-for-pin functional equivalent Alternate Source Directory ever available. This directory was developed by asking each IC manufacturer to identify each competitive device for which he made a pin-for-pin interchangeable alternate. This unique approach took nearly two years to complete, is updated quarterly, and sales countless manhours of catalog searching and specification comparison.

MASTER SELECTION GUIDE This Guide, covering virtually every facet of the industry, organizes ICs into these categories: Digital, Interface, Linear, Memory and Microprocessors. In each category, products are further classified by type (CMOS, ECL, TTL, etc.) and function (Arithmetic, Counters, Gates, etc.). You'll find every IC performing that function listed by part number and manufacturer. The Five Master Selection Guides will allow you to search for ICs by your specific requirements and identify all major available devices and sources.

MANUFACTURER & DISTRIBUTOR DIRECTORY Locate the nearest local source for additional information or quick delivery of needed products. A fingertip communications guide listing the location and phone number for all manufacturer's field sales offices, reps, and distributors, both domestic and international.

PRODUCT INDEX Arranges 84 IC manufacturers in alphabetical order by manufacturer and provides a complete alphanumeric listing of each company's IC standard product line. Adjacent page number references are provided for instant referral to needed technical information.

QUARTERLY UPDATES This assures that all this vast body of information is constantly refreshed. Your guarantee that the IC MASTER will remain the most complete and current industry-wide source available for the first step in IC selection.

DIGITAL

- CMOS
- ECL
- HNIL/HTL
- TTL
- Special

DIGITAL

INTERFACE

- Analog Switches
- A/D Converters
- Binary Decimal
- D/A Converters
- Display Drivers
- Error Checking Circuits
- Keyboard Encoders
- Line Drivers, Receivers and Transceivers
- Memory and Peripheral Drivers
- Sense Amplifiers
- Serial Transmitters-Receivers

INTERFACE

LINEAR

- Amplifiers, Special Purpose
- Arrays
- Comparators
- Followers
- Operational Amplifiers
- Phase Locked Loop Circuits
- Telecommunication Circuits
- Timers
- Voltage Regulators
- Other Linear Devices

LINEAR

MEMORY

- Character Generators
- Code Converters
- EAROMs
- FIFOs, LIFOs, PLAS
- PROMs
- RAMs
- ROMs
- Shift Registers

MEMORY

MICROPROCESSORS

- Systems Components
- Selection Table
  - General Structure
  - Architecture
  - Hardware Support
  - Software Support
  - Alternate Sources

MICROPROCESSOR

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PART NUMBER INDEX

This index shows the page and line on that page where each device appears in the Master Selection Guide, and application notes are indicated by a ¶ sign. The list is prepared by a computer from the data in these sections so every device in them is listed. The devices are arranged in order by basic numbers so similarly numbered devices from various manufacturers are grouped together. Bold faced listings lead to the data supplied by the manufacturers. Use this index to locate key operational characteristics, application notes, and devices data whenever you have a model number.

how to use the part number index

This Part Number Index is arranged in alpha-numeric sequence, ignoring the manufacturer's prefixes and suffixes and using the basic model numbers. This basic number sequence is sorted by reading the digits from **left** to **right,** assuming that letters come before numbers. (As an example, these numbers would appear in the following order: 5301, 531, 54H01, 54139, 5414.) Under each basic number, the manufacturer's name and full model number is listed. The page references in **BOLD FACE** lead to manufacturers' data and application notes are indicated by a ¶ sign.

The arrangement of this index by base number gives you several advantages. It allows you to find a device by its basic number whether or not you know the name of the manufacturer or the manufacturer's prefixes. Also it groups similar devices together so that when you are looking for data you can quickly determine if the data has been provided in the book by any of the manufacturers and where that data is. Similarly it groups any references to application notes close together so that you do not need to guess which manufacturer might publish application notes on a device before you can locate them.

Once you become familiar with the alpha-numeric numbering sequence, you'll find that this index is very easy to use.

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Base Number	Source	Device	Page-Line
	Fairchild	FQ 3724	514-89
		FQ 3725	514-90
CGA	TRW	CGA	202-33
			609-10
DAC-S-CBI	DDC	DAC-S-CBI	378-86
DAC-S-CCD	DDC	DAC-S-CCD	377-89
ECL	Fairchild	ECL SERIES	¶ 93-10
ECL-Array	Plessey	ECL-ARRAY	202-30
			571-115
FIPS	**National**	**FIPS**	★ **986**
GCP/P	National	GCP/P	¶128-15
ILL-Array	Plessey	ILL-ARRAY	202-31
LX	National	LX SERIES	¶118-15
			¶118-16
			¶118-18
			¶118-22
MonochipM	Interdesign	MonochipM	160-172
MasterMos	IMI	MASTERMOS	160-171
			202-26
MECL	Motorola	MECL	¶ 93-11
			¶ 93-13
			¶ 93-14
			¶ 93-16
			¶ 93-19
			¶ 94- 5
			¶ 94- 6
Monochip	Interdesign	MONOCHIP	202-25
			571-114
OMEGA	GI	OMEGA	526-166
PACE	**National**	**PACE**	★ **986**
			★ **1022**
			★ **1077**
			866-154
			¶125- 6
			¶129- 3
RL	Reticon	RL SERIES	¶113-12
RTL-Array	Plessey	RTL-ARRAY	202-32
			571-117
SAD	Reticon	SAD	¶119- 9
SAM	Reticon	SAM	¶119- 9
SAP	Reticon	SAP	¶119- 9
SC/MP	**National**	**SC/MP**	★ **986**
			★ **998**
			★ **1077**
			867-81
			¶125-13
			¶125-13
			¶129- 7
			¶129- 7
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SWAP	SW	SWAP	571-118
TAD	Reticon	TAD	¶119- 9
TTL-Array	Plessey	TTL-ARRAY	571-116
ULA	Ferranti	ULA	202-24
			571-113
XR-CHIP	Exar	XR-CHIP	202-23
			571-111
XR-IIL-Chip	Exar	XR-IIL-CHIP	202-22
			571-112
00	**National**	**IMP-00A/520**	★ **1051**
			866-47
0001	National	LH0001	535-39
			¶101- 8
		LH0001A	539-48
		LH0001AC	544-19
0002	National	LH0002	512-22
			¶ 97- 9
		LH0002C	512-23
0003	National	LH0003	529-103
			532-121
			541-11
		LH0003C	532-122
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		LH0004C	530-18
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0005	National	LH0005	529-117
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		LH0005A	529-118
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			532-125
			549-45
0006	National	DH0006	395-125
		DH0006C	395-126
0007	National	MH0007	394-12
			¶124- 2
		MH0007C	394-14
0008	National	DH0008	395-128
		DH0008C	395-129
0009	National	MH0009	394-25
		MH0009C	394-26
001	Solitron	CJCA001	570-22
		CJSE001	564-72
0011	National	DH0011	396-31
		DH0011C	396-32
0012	National	MH0012	394-13
		MH0012C	394-15
0013	National	MH0013	394-27
		MH0013C	394-28
0014	National	AH0014	368-52
		AH0014C	368-53
		LH0014	¶116-10
0015	National	AH0015	365-13
		AH0015C	365-14
0016	National	DH0016C	396-34
0017	National	DH0017C	396-35
0018	National	DH0018C	396-36
0019	National	AH0019	368- 5
		AH0019C	368- 6
		LH0019	¶116-10
002	Solitron	CJCA002	570-70
		CJSE002	567-23
0020	National	LH0020	529-120
			539-56
		LH0020C	529-121
			546-22
0021	National	LH0021	529-85
			541- 4
		LH0021C	529-90
			546-25
0022	National	LH0022	541-19
			¶100-14
		LH0022C	545-52
			¶100-14
0023	National	LH0023	573-76
		LH0023C	573-77
0024	National	LH0024	530-74
			532-161
			542- 2
		LH0024C	530-66
			532-162
			548-50
0025	**National**	**DS0025**	★ **473**
			394-29
			¶120- 9
		DS0025C	★ **473**
			394-30
0026	AMD	0026	394-16
			¶120- 7
		0026C	394-17
	Motorola	MMH0026	394-23
		MMH0026C	394-24
	National	**DS0026**	★ **474**
			394-31
			¶120- 9
		DS0026C	★ **474**
			394-32
0028	National	DH0028C	397-18
003	Solitron	CJSE003	564-73
0032	National	LH0032	530-71
			532-163
			542-50
		LH0032C	530-72
			532-164
			550-46
0033	National	LH0033	528- 2
			¶110- 8
		LH0033C	528- 3
			¶110- 8
0034	National	DH0034	198-120
		DH0034C	198-121

Base Number	Source	Device	Page-Line
0035	National	DH0035	572-136
			¶116-13
		DH0035C	572-137
			¶116-13
0036	National	LH0036	512-75
		LH0036C	512-76
0037	National	LH0037	512-77
		LH0037C	512-78
004	Solitron	CJSE004	567-24
0041	National	LH0041	529-100
			541- 2
		LH0041C	529-101
			546-20
0042	AD	AD0042C	551-27
	National	LH0042	551-19
		LH0042C	551-25
			¶100-14
0043	National	LH0043	573-78
		LH0043C	573-79
0044	National	LH0044	531-69
			533-14
		LH0044A	531-49
			533- 7
		LH0044AC	531-50
			533- 8
		LH0044B	531-51
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		LH0044C	531-70
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0045	National	LH0045	512-177
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005	Solitron	CJSE005	564-74
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0052	National	LH0052	531-27
			533-46
			¶100-14
			¶100-14
		LH0052C	531-36
			535- 9
			¶100-14
			¶100-14
0053	National	LH0053	573-80
		LH0053C	573-81
0056	AMD	0056	394-18
		0056C	394-19
	National	**DS0056**	★ **474**
			394-33
		DS0056C	★ **474**
			394-34
006	Solitron	CJSE006	567-25
0061	National	LH0061	529-92
			541-47
		LH0061C	529-93
			550- 5
	TI	LH0061	529-94
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0062	National	LH0062	530-34
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			¶100-17
			¶100-17
		LH0062C	530-35
			550-44
			¶100-17
			¶100-17
0063	National	LH0063	528- 4
		LH0063C	528- 5
007	Solitron	CJCA007	570-23
0070	National	LH0070	573-24
0071	Lithic Sys	LH0071	573-27
	National	LH0071	573-28
008	Solitron	CJCA008	570-71
009	Solitron	CJSE009	565-10
01	PMI	CMP-01	516- 4
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			¶109-13
		CMP-01C	516-29
		CMP-01E	516- 5
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			¶109-12
		DAC-01A	376-10
		DAC-01B	376-12

Base Number	Source	Device	Page-Line
01	PMI	DAC-01C	376-13
		DAC-01F	376-14
		DAC-01H	376-15
		MAT-01	514-28
			514-41
			¶111- 4
			¶111- 4
		OP-01	534-53
		OP-01C	543-46
		OP-01E	538- 9
		OP-01F	538-10
		OP-01G	543-47
		OP-01H	534-54
		REF-01	573-25
010	Harris	HM-010	202-111
	Solitron	CJSE010	567-47
0104	Harris	HM-0104	202-131
011	Solitron	CJSE011	565-11
0110	Harris	HM-0110	202-122
012	Harris	HM-012	202-112
	Solitron	CJSE012	567-48
0126	National	AH0126	367-93
		AH0126C	367-94
0129	National	AH0129	367-66
		AH0129C	367-67
013	Fairchild	SH013C	394-20
		SH013M	394-21
	Harris	HM-013	202-113
	Solitron	CJSE013	565-12
0133	National	AM0133	363-80
		AM0133C	363-81
0134	National	AH0134	364- 8
		AH0134C	364- 9
0139	National	AH0139	368-31
		AH0139C	368-32
014	Solitron	CJSE014	567-49
0140	National	AH0140	367-47
		AH0140C	367-48
0141	National	AM0141	363-58
		AM0141C	363-59
0142	National	AH0142	368-42
		AH0142C	368-43
0143	National	AH0143	365-101
		AH0143C	365-102
0144	National	AH0144	365-72
		AH0144C	365-73
0145	National	AH0145	368-18
		AH0145C	368-19
0146	National	AH0146	365-53
		AH0146C	365-54
0151	National	AM0151	363-64
		AM0151C	363-65
0152	National	AM0152	363-90
		AM0152C	363-91
0153	National	AH0153	367-53
		AH0153C	367-54
0154	Hughes	HCTR0154	151-119
	National	AH0154	367-74
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0161	National	AH0161	365-60
		AH0161C	365-61
0162	National	AH0162	365-80
		AH0162C	365-81
0163	National	AH0163	368-22
		AH0163C	368-23
0164	National	AH0164	368-36
		AH0164C	368-37
0165	Harris	HD-0165	583-18
		HD0165	¶ 92-17
0168	Harris	HM-0168	202-136
017	Solitron	CJSE017	563-18
0174	Hughes	HPLA0174	160-68
			608-103
018	Solitron	CJSE018	566-44
0186	Harris	HM-0186	202-141
019	Solitron	CJSE019	563-19
02	PMI	AD-02	373-66
			374-45
		AD-02W	373-67
			374-46
		CMP-02	516- 2
		CMP-02C	516-28
		CMP-02E	516- 3

Arranged alphanumerically from left to right

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Base Number	Source	Device	Page-Line
02	PMI	DAC-02AC	377-72
		DAC-02BC	377-73
		DAC-02CD	377-74
		DAC-02DD	377-75
		OP-02	538-11
		OP-02A	534-47
		OP-02C	538-12
		OP-02E	534-48
		REF-02	572-180
			573-129
			¶119- 7
			¶119- 7
020	Solitron	CJSE020	566-45
0200	Hughes	HCTR0200	151-59
021	Solitron	CJSE021	563-20
022	TI	TL022C	554-12
		TL022M	554- 6
03	PMI	DAC-03AD	377-19
		DAC-03BD	377-20
		DAC-03CD	377-21
		DAC-03DD	377-22
030	Harris	HM-030	202-133
031	Harris	HM-031	202-134
0320	Hughes	HCTR0320	559-76
0321	Hughes	HSSR0321	159-115
			632-21
0323	Fairchild	SH0323	562-87
034	Harris	HM-034	202-135
0340	Hughes	HCTR0340	559-78
0347	Hughes	HCTR0347	559-79
0351	Hughes	HSSR0351	159-116
			632-22
036T1	SGS	L036T1	563-110
037T1	SGS	L037T1	564-24
04	PMI	DAC-04AC	377-68
		DAC-04BC	377-69
		DAC-04CC	377-70
		DAC-04DD	377-71
		OP-04	553- 8
		OP-04A	552-43
		OP-04C	553- 9
		OP-04E	552-44
040	Harris	HM-040	202-138
0400	TI	SBP0400	¶130-10
		SBP0400AC	★**102**
			867-75
		SBP0400AM	★**102**
			867-76
0401	**TI**	**SBP0401A**	★**103**
			867-77
041	Harris	HM-041	202-139
	Siemens	S041	523-75
042	Siemens	S042	512-111
044	Harris	HM-044	202-140
	TI	TL044C	557-13
		TL044M	556-46
0470	ITT	TDA0470	524-74
05	PMI	OP-05	531-74
			534-32
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051	Harris	HM-051	202-129
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0525	Hughes	HSUB0525	525-21
055	Harris	HM-055	202-130
060	Sprague	060	¶114- 9
07	PMI	OP-07	531-83
			533-19
			¶101-18
			¶101-18
			¶101-19
			¶101-19

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			533- 4
		OP-07C	531-92
			533-36
		OP-07E	531-84
			533-22
	Rockwell	A07XX	867- 5
074	Harris	HM-074	202-107
075	Harris	HM-075	202-108
076	Harris	HM-076	202-109
08	AMD	DAC-08	376-76
	PMI	DAC-08	376-77
			376-78
			¶109-10
			¶109-10
			¶109-14
			¶109-14
			¶109-15
			¶109-15
		DAC-08A	376-74
		DAC-08CZ	376-81
	Rockwell	A08XX	867- 6
080	Harris	HM-080	202-115
081	Harris	HM-081	202-116
	SGS	M081	524-69
	TI	TL081	549- 6
		TL081AC	545-53
		TL081C	550-49
082	SGS	M082	524-70
084	Harris	HM-084	202-117
	TI	TL084	558-30
087	SGS	M087	524-71
089	TI	TL089C	533-32
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090	Harris	HM-090	202-119
091	Harris	HM-091	202-120
093	Harris	HM-093	202-121
1	Datel	SHM-IC-1	573-66
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54LS374	AMD	SN54LS374	182-97
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	TI	SN54LS395	196-183
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	National	DM54LS42	176-92
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	Motorola	MC75461	395-73
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75462	Fairchild	75462	395-153
	ITT	ITT75462	395-157
	Motorola	MC75462	395-159
	National	DS75462	396- 2
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75463	Fairchild	75463	396-72
	Hitachi	75463	396-77
	ITT	ITT75463	396-79
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	National	DS75463	396-85
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	ITT	ITT75464	396-130
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76005	TI	SN76005	521-161
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7602	**Harris**	**HM7602**	**★ 682**
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76021	TI	SN76021	521-129
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7603	**Harris**	**HM7603**	**★ 682**
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8915	Fujitsu	MB8915	398-162
8916	Fujitsu	MB8916	398-164
8920	Plessey	SP8920	559-93
8921	Plessey	SP8921	559-94
8922	Plessey	SP8922	559-95
8923	Plessey	SP8923	559-96
8963	National	DS8963	381-95
8973	National	DS8973	381-103
8974	National	DS8974	381-104
8976	National	DS8976	381-105
8977	National	DS8977	381-85
8996	**AMI**	**S8996**	★ **634**
			624-12
9LS00	Fairchild	9LS00C	186-81
		9LS00M	186-82
	Raytheon	**9LS00**	★ **210**
		9LS00C	★ **210**
			186-87
		9LS00M	★ **210**
			186-88
9LS01	**Raytheon**	**9LS01**	★ **212**
		9LS01C	★ **212**
			187-32
		9LS01M	★ **212**
			187-33
9LS02	Fairchild	9LS02C	190-117
		9LS02M	190-118
	Raytheon	**9LS02**	★ **214**
		9LS02C	190-123
		9LS02M	★ **214**
			190-124
9LS03	Fairchild	9LS03C	187-22
		9LS03M	187-23
	Raytheon	**9LS03**	★ **212**
		9LS03C	★ **212**
			187-37

Arranged alphanumerically from left to right

IC MASTER

Base Number	Source	Device	Page-Line
9LS03	**Raytheon**	**9LS03M**	**★ 212**
			187-38
9LS04	Fairchild	9LS04C	170-152
		9LS04M	170-153
	Raytheon	**9LS04**	**★ 210**
		9LS04C	**★ 210**
			170-158
		9LS04M	**★ 210**
			170-159
9LS05	Fairchild	9LS05C	171-33
		9LS05M	171-34
	Raytheon	**9LS05**	**★ 212**
		9LS05C	**★ 212**
			171-39
		9LS05M	**★ 212**
			171-40
9LS08	Fairchild	9LS08C	183-182
		9LS08M	183-183
	Raytheon	**9LS08**	**★ 215**
		9LS08C	**★ 215**
			183-188
		9LS08M	**★ 215**
			183-189
9LS09	Fairchild	9LS09C	184-44
		9LS09M	184-45
	Raytheon	**9LS09**	**★ 217**
		9LS09C	**★ 217**
			184-50
		9LS09M	**★ 217**
			184-51
9LS10	Fairchild	9LS10C	185-176
		9LS10M	185-177
	Raytheon	**9LS10**	**★ 210**
		9LS10C	**★ 210**
			185-182
		9LS10M	**★ 210**
			185-183
9LS107	**Raytheon**	**9LS107**	**★ 232**
		9LS107C	**★ 232**
			181-27
		9LS107M	**★ 232**
			181-28
9LS109	Fairchild	9LS109C	180-68
		9LS109M	180-69
	Raytheon	**9LS109**	**★ 251**
		9LS109C	**★ 251**
			180-78
		9LS109M	**★ 251**
			180-79
9LS11	Fairchild	9LS11C	183-84
		9LS11M	183-85
	Raytheon	**9LS11**	**★ 215**
		9LS11C	**★ 215**
			183-90
		9LS11M	**★ 215**
			183-92
9LS112	Fairchild	9LS112C	180-132
		9LS112M	180-133
	Raytheon	**9LS112**	**★ 232**
		9LS112C	**★ 232**
			180-142
		9LS112M	**★ 232**
			180-143
9LS113	Fairchild	9LS113C	180-90
		9LS113M	180-91
	Raytheon	**9LS113**	**★ 232**
		9LS113C	**★ 232**
			180-96
		9LS113M	**★ 232**
			180-97
9LS114	Fairchild	9LS114C	180-116
		9LS114M	180-117
	Raytheon	**9LS114**	**★ 237**
		9LS114C	**★ 237**
			180-122
		9LS114M	**★ 237**
			180-123
9LS12	**Raytheon**	**9LS12**	**★ 212**
		9LS12C	**★ 212**
			186-40
		9LS12M	**★ 212**
			186-41
9LS13	**Raytheon**	**9LS13**	**★ 218**

Base Number	Source	Device	Page-Line
9LS13	**Raytheon**	**9LS13C**	**★ 218**
			200-69
		9LS13M	**★ 218**
			200-70
9LS132	Fairchild	9LS132C	200-90
		9LS132M	200-91
9LS136	Fairchild	9LS136C	189-127
		9LS136M	189-128
	Raytheon	**9LS136**	**★ 253**
		9LS136C	**★ 253**
			189-136
		9LS136M	**★ 253**
			189-137
9LS138	Fairchild	9LS138C	177-92
		9LS138M	177-93
	Raytheon	**9LS138**	**★ 254**
		9LS138C	**★ 254**
			177-98
		9LS138M	**★ 254**
			177-99
9LS139	Fairchild	9LS139C	177-53
		9LS139M	177-54
	Raytheon	**9LS139**	**★ 254**
		9LS139C	**★ 254**
			177-59
		9LS139M	**★ 254**
			177-60
9LS14	Fairchild	9LS14C	200-120
		9LS14M	200-121
	Raytheon	**9LS14**	**★ 218**
		9LS14C	**★ 218**
			200-129
		9LS14M	**★ 218**
			200-130
9LS15	Fairchild	9LS15C	183-125
		9LS15M	183-126
	Raytheon	**9LS15**	**★ 217**
		9LS15C	**★ 217**
			183-135
		9LS15M	**★ 217**
			183-136
9LS151	Fairchild	9LS151C	194-112
		9LS151M	194-113
	Raytheon	**9LS151**	**★ 256**
		9LS151C	**★ 256**
			194-118
		9LS151M	**★ 256**
			194-119
9LS152	Fairchild	9LS152C	194-43
		9LS152M	194-44
	Raytheon	**9LS152**	**★ 256**
		9LS152C	**★ 256**
			194-47
		9LS152M	**★ 256**
			194-48
9LS153	Fairchild	9LS153C	193-144
		9LS153M	193-145
	Raytheon	**9LS153**	**★ 258**
		9LS153C	**★ 258**
			193-150
		9LS153M	**★ 258**
			193-151
9LS155	Fairchild	9LS155C	176-193
		9LS155M	176-194
	Raytheon	**9LS155**	**★ 260**
		9LS155C	**★ 260**
			177- 9
		9LS155M	**★ 260**
			177-10
9LS156	Fairchild	9LS156C	177-36
		9LS156M	177-37
	Raytheon	**9LS156**	**★ 260**
		9LS156C	**★ 260**
			177-42
		9LS156M	**★ 260**
			177-43
9LS157	Fairchild	9LS157C	192-106
		9LS157M	192-107
	Raytheon	**9LS157**	**★ 262**
		9LS157C	**★ 262**
			192-110
		9LS157M	**★ 262**
			192-111

Base Number	Source	Device	Page-Line
9LS158	Fairchild	9LS158C	192-178
		9LS158M	192-179
	Raytheon	**9LS158**	**★ 262**
		9LS158C	**★ 262**
			192-184
		9LS158M	**★ 262**
			192-185
9LS160	Fairchild	9LS160C	174-55
		9LS160M	174-56
	Raytheon	**9LS160**	**★ 264**
		9LS160C	**★ 264**
			174-61
		9LS160M	**★ 264**
			174-62
9LS161	Fairchild	9LS161C	172-126
		9LS161M	172-127
	Raytheon	**9LS161**	**★ 264**
		9LS161C	**★ 264**
			172-137
		9LS161M	**★ 264**
			172-138
9LS162	Fairchild	9LS162C	174-105
		9LS162M	174-106
	Raytheon	**9LS162**	**★ 264**
		9LS162C	**★ 264**
			174-111
		9LS162M	**★ 264**
			174-112
9LS163	Fairchild	9LS163C	172-72
		9LS163M	172-73
	Raytheon	**9LS163**	**★ 264**
		9LS163C	**★ 264**
			172-78
		9LS163M	**★ 264**
			172-79
9LS164	Fairchild	9LS164C	197-182
		9LS164M	197-183
	Raytheon	**9LS164**	**★ 271**
		9LS164C	**★ 271**
			197-188
		9LS164M	**★ 271**
			197-189
9LS170	Fairchild	9LS170C	192- 9
		9LS170M	192-10
9LS174	Fairchild	9LS174C	182-172
		9LS174M	182-173
	Raytheon	**9LS174**	**★ 275**
		9LS174C	**★ 275**
			182-178
		9LS174M	**★ 275**
			182-179
9LS175	Fairchild	9LS175C	182-44
		9LS175M	182-45
	Raytheon	**9LS175**	**★ 275**
		9LS175C	**★ 275**
			182-51
		9LS175M	**★ 275**
			182-50
9LS181	Fairchild	9LS181C	169-36
		9LS181M	169-37
	Raytheon	**9LS181**	**★ 277**
		9LS181C	**★ 277**
			169-40
		9LS181M	**★ 277**
			169-41
9LS190	Fairchild	9LS190C	174-188
		9LS190M	174-189
	Raytheon	**9LS190**	**★ 283**
		9LS190C	**★ 283**
			174-194
		9LS190M	**★ 283**
			175- 5
9LS191	Fairchild	9LS191C	173- 8
		9LS191M	173- 9
	Raytheon	**9LS191**	**★ 283**
		9LS191C	**★ 283**
			173-14
		9LS191M	**★ 283**
			173-15
9LS192	Fairchild	9LS192C	175-47
		9LS192M	175-48
	Raytheon	**9LS192**	**★ 291**
		9LS192C	**★ 291**

Base Number	Source	Device	Page-Line
9LS192	Raytheon	9LS192C	175-53
		9LS192M	**★ 291**
			175-54
9LS193	Fairchild	9LS193C	173-60
		9LS193M	173-61
	Raytheon	**9LS193**	**★ 291**
		9LS193C	**★ 291**
			173-71
		9LS193M	**★ 291**
			173-72
9LS194	Fairchild	9LS194C	196-130
		9LS194M	196-135
	Raytheon	**9LS194A**	**★ 299**
		9LS194AC	**★ 299**
			196-140
		9LS194AM	**★ 299**
			196-141
9LS195	Fairchild	9LS195C	196-41
		9LS195M	196-42
	Raytheon	**9LS195A**	**★ 302**
		9LS195AC	**★ 302**
			196-47
		9LS195AM	**★ 302**
			196-48
9LS196	Fairchild	9LS196C	173-192
		9LS196M	173-193
	Raytheon	**9LS196**	**★ 305**
		9LS196C	**★ 305**
			174- 8
		9LS196M	**★ 305**
			174- 9
9LS197	Fairchild	9LS197C	172-21
		9LS197M	172-22
	Raytheon	**9LS197**	**★ 305**
		9LS197C	**★ 305**
			172-27
		9LS197M	**★ 305**
			172-28
9LS20	Fairchild	9LS20C	184-176
		9LS20M	184-177
	Raytheon	**9LS20**	**★ 210**
		9LS20C	**★ 210**
			184-182
		9LS20M	**★ 210**
			184-183
9LS21	Fairchild	9LS21C	183-41
		9LS21M	183-42
	Raytheon	**9LS21**	**★ 215**
		9LS21C	183-47
		9LS21M	**★ 215**
			183-49
9LS22	Fairchild	9LS22C	185-103
		9LS22M	185-104
	Raytheon	**9LS22**	**★ 212**
		9LS22C	**★ 212**
			185-109
		9LS22M	**★ 212**
			185-110
9LS251	Fairchild	9LS251C	194-165
		9LS251M	194-166
	Raytheon	**9LS251**	**★ 309**
		9LS251C	**★ 309**
			194-171
		9LS251M	**★ 309**
			194-172
9LS253	Fairchild	9LS253C	193-177
		9LS253M	193-178
	Raytheon	**9LS253**	**★ 312**
		9LS253C	**★ 312**
			193-183
		9LS253M	**★ 312**
			193-184
9LS255	**Raytheon**	**9LS255**	**★ 313**
		9LS255C	**★ 313**
			177-122
		9LS255M	**★ 313**
			177-123
9LS257	Fairchild	9LS257C	193-41
		9LS257M	193-42
	Raytheon	**9LS257**	**★ 315**
		9LS257C	**★ 315**
			193-47
		9LS257M	**★ 315**

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★ Indicates additional data is provided on the page noted

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Base Number	Source	Device	Page-Line
9LS257	Raytheon	9LS257M	193-48
9LS258	Fairchild	9LS258C	193-21
		9LS258M	193-22
	Raytheon	**9LS258**	★ 315
		9LS258C	★ 315
			193-25
		9LS258M	★ 315
			193-26
9LS26	**Raytheon**	**9LS26**	★ 222
		9LS26C	★ 222
			187-128
		9LS26M	★ 222
			187-129
9LS261	**Raytheon**	**9LS261**	★ 318
		9LS261C	★ 318
			168-124
		9LS261M	★ 318
			168-125
9LS266	Fairchild	9LS266C	189-158
		9LS266M	189-159
	Raytheon	**9LS266**	★ 253
		9LS266C	★ 253
			189-162
		9LS266M	★ 253
			189-163
9LS27	Fairchild	9LS27C	190-76
		9LS27M	190-77
	Raytheon	**9LS27**	★ 214
		9LS27C	★ 214
			190-82
		9LS27M	★ 214
			190-83
9LS279	Fairchild	9LS279C	191-128
		9LS279M	191-129
9LS28	**Raytheon**	**9LS28**	★ 223
		9LS28C	★ 223
			190-131
		9LS28M	★ 223
			190-132
9LS283	Fairchild	9LS283C	168-58
		9LS283M	168-59
	Raytheon	9LS283C	168-76
		9LS283M	168-78
9LS295	Fairchild	9LS295C	196-159
		9LS295M	196-160
	Raytheon	**9LS295A**	★ 321
		9LS295AC	★ 321
			196-165
		9LS295AM	★ 321
			196-166
9LS298	AMD	9LS298C	193-93
		9LS298M	193-94
	Fairchild	9LS298C	182-117
			193-99
		9LS298M	182-118
			193-100
	Raytheon	**9LS298**	★ 323
		9LS298C	★ 323
			182-123
		9LS298M	★ 323
			182-124
9LS30	Fairchild	9LS30C	184-100
		9LS30M	184-101
	Raytheon	**9LS30**	★ 210
		9LS30C	★ 210
			184-106
		9LS30M	★ 210
			184-107
9LS32	Fairchild	9LS32C	190- 7
		9LS32M	190- 8
	Raytheon	**9LS32**	★ 225
		9LS32C	★ 225
			190-13
		9LS32M	★ 225
			190-14
9LS33	**Raytheon**	**9LS33**	★ 226
		9LS33C	★ 226
			190-160
		9LS33M	★ 226
			190-161
9LS365	**Raytheon**	**9LS365**	★ 325
		9LS365C	★ 325
			170-96
9LS365	**Raytheon**	**9LS365M**	★ 325
			170-97
9LS366	**Raytheon**	**9LS366**	★ 325
		9LS366C	★ 325
			171-94
		9LS366M	★ 325
			171-95
9LS37	Fairchild	9LS37C	186-145
		9LS37M	186-146
	Raytheon	**9LS37**	★ 223
		9LS37C	★ 223
			★ 223
			186-151
			186-152
		9LS37M	★ 223
9LS38	Fairchild	9LS38C	187-102
		9LS38M	187-103
	Raytheon	**9LS38**	★ 226
		9LS38C	★ 226
			187-106
		9LS38M	★ 226
			187-107
9LS386	**Raytheon**	**9LS386**	★ 242
		9LS386C	★ 242
			189-91
		9LS386M	★ 242
			189-92
9LS395	**Raytheon**	**9LS395**	★ 327
		9LS395C	★ 327
			196-179
		9LS395M	★ 327
			196-180
9LS40	Fairchild	9LS40C	185-52
		9LS40M	185-53
	Raytheon	**9LS40**	★ 223
		9LS40C	★ 223
			185-58
		9LS40M	★ 223
			185-59
9LS42	Fairchild	9LS42C	176-88
		9LS42M	176-89
	Raytheon	**9LS42**	★ 227
		9LS42C	★ 227
			176-94
		9LS42M	★ 227
			176-95
9LS43	**Raytheon**	**9LS43**	★ 227
		9LS43C	★ 227
			176-13
		9LS43M	★ 227
			176-14
9LS44	**Raytheon**	**9LS44**	★ 227
		9LS44C	★ 227
			176-34
		9LS44M	★ 227
			176-35
9LS51	Fairchild	9LS51C	188-129
		9LS51M	188-130
	Raytheon	**9LS51**	★ 230
		9LS51C	★ 230
			188-135
		9LS51M	★ 230
			188-136
9LS54	Fairchild	9LS54C	187-184
		9LS54M	187-185
	Raytheon	**9LS54**	★ 230
		9LS54C	187-192
		9LS54M	★ 230
			188- 5
9LS55	Fairchild	9LS55C	188-144
		9LS55M	188-145
	Raytheon	**9LS55**	★ 230
		9LS55C	★ 230
			188-150
		9LS55M	★ 230
			188-151
9LS73	Fairchild	9LS73C	181-13
		9LS73M	181-14
	Raytheon	**9LS73**	★ 232
		9LS73C	★ 232
			181-23
		9LS73M	★ 232
			181-24
9LS74	Fairchild	9LS74C	181-153
		9LS74M	181-154
	Raytheon	**9LS74**	★ 235
		9LS74C	★ 235
			181-159
		9LS74M	★ 235
			181-160
9LS76	**Raytheon**	**9LS76**	★ 232
		9LS76C	★ 232
			181-86
		9LS76M	★ 232
			181-87
9LS78	**Raytheon**	**9LS78**	★ 237
		9LS78C	★ 237
			180-39
		9LS78M	★ 237
			180-40
9LS83	Fairchild	9LS83C	168-56
		9LS83M	168-57
	Raytheon	**9LS83A**	★ 239
		9LS83AC	★ 239
			168-72
		9LS83AM	★ 239
			168-73
9LS85	**Raytheon**	**9LS85**	★ 241
		9LS85C	★ 241
			169-186
		9LS85M	★ 241
			169-187
9LS86	Fairchild	9LS86C	189-83
		9LS86M	189-84
	Raytheon	**9LS86**	★ 242
		9LS86C	★ 242
			189-87
		9LS86M	★ 242
			189-88
9LS90	Fairchild	9LS90C	173-137
		9LS90M	173-138
	Raytheon	**9LS90**	★ 243
		9LS90C	★ 243
			173-145
		9LS90M	★ 243
			173-146
9LS92	**Raytheon**	**9LS92**	★ 243
		9LS92C	★ 243
			175-119
		9LS92M	★ 243
			175-120
9LS93	Fairchild	9LS93C	171-142
		9LS93M	171-143
	Raytheon	**9LS93**	★ 243
		9LS93C	★ 243
			171-150
		9LS93M	★ 243
			171-151
9LS95	Fairchild	9LS95C	196-96
		9LS95M	196-97
9PS02	**Raytheon**	**9PS02C**	★ 214
9PS54	**Raytheon**	**9PS54C**	★ 230
9S04	Fairchild	9S04AC	170-185
		9S04AM	170-186
9S05	Fairchild	9S05AC	171-68
		9S05AM	171-69
9S41	Fairchild	9S41C	184-71
		9S41M	184-72
9S42	Fairchild	9S42C	187-143
		9S42M	187-144
90	Burr-Brown	DAC90J	376-90
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		DAC90L	376-86
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9000	Fairchild	9000C	179-74
		9000M	179-75
9001	Fairchild	9001C	179-76
		9001M	179-77
	ITT	ITT9001	179-82
9002	EA	EA9002	871-121
9002	Fairchild	9002C	186-53
		9002M	186-54
	ITT	ITT9002-1	186-61
		ITT9002-5	186-62
	National	DM9002C	186-70
9003	Fairchild	9003C	185-151
		9003M	185-152
	ITT	ITT9003-1	185-159
		ITT9003-5	185-160
	National	DM9003C	185-165
9004	Fairchild	9004C	184-151
		9004M	184-152
	ITT	ITT9004-1	184-159
		ITT9004-5	184-160
	National	DM9004C	184-165
9005	Fairchild	9005C	188-176
		9005M	188-177
	ITT	ITT9005-1	188-184
		ITT9005-5	188-185
	National	DM9005C	188-190
9006	Fairchild	9006C	189-47
		9006M	189-48
	National	DM9006C	189-49
9007	Fairchild	9007C	184-76
		9007M	184-77
9008	Fairchild	9008C	187-158
		9008M	187-159
	ITT	ITT9008-1	187-160
		ITT9008-5	187-161
	National	DM9008C	187-162
9009	Fairchild	9009C	185-29
		9009M	185-30
	ITT	ITT9009-1	185-37
		ITT9009-5	185-38
	National	DM9009C	185-43
901	Plessey	SL901	525-108
9012	Fairchild	9012C	186-168
		9012M	186-169
	ITT	ITT9012	170-134
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95000	Fairchild	F95000	164-117
95002	Fairchild	F95002	164-100
95003	Fairchild	F95003	164-104
95004	Fairchild	F95004	164-96
95010	Fairchild	F95010	164-78
95016	Fairchild	F95016	164-76
95029	Fairchild	F95029	164-81
9503	Collins	CRC9503	¶ 87- 9
9504	Collins	CRC9504	¶ 87- 9
9505	Collins	CRC9505	368-55
9509	Collins	CRC9509	370-45
9510	Collins	CRC9510	370-58
95101	Fairchild	F95101	164-111
95102	Fairchild	F95102	164-108
95103	Fairchild	F95103	164-106
95105	Fairchild	F95105	164-102
95106	Fairchild	F95106	164-94
95107	Fairchild	F95107	164-86
95109	Fairchild	F95109	164-98
95110	Fairchild	F95110	164-89
95111	Fairchild	F95111	164-92
95115	Fairchild	F95115	164-125
95116	Fairchild	F95116	164-123
95124	Fairchild	F95124	164-120
95130	Fairchild	F95130	164-114
95231	Fairchild	F95231	164-83
9538	Fairchild	9538	¶ 93- 9
9551	AMD	9551C	870-174
		9551M	870-175
9555	AMD	9555C	871-45
		9555M	871-46
96L02	Fairchild	96L02C	195-124
		96L02M	195-125
96S02	Fairchild	96S02C	195-145
		96S02M	195-146
96S21	**Raytheon**	**96S21C**	★ **215**
960	Signetics	TAA960	512-20
9600	AMD	9600C	195-75
		9600M	195-76
	Fairchild	9600	¶ 96-18
		9600C	195-79
		9600M	195-80
9601	AMD	9601C	195-51
		9601M	195-52
	Fairchild	9601	¶ 96-18
		9601C	195-53
		9601M	195-54
	ITT	ITT9601-1	195-55
		ITT9601-5	195-56
	Motorola	MC9601	195-58
	National	DM9601	195-60
	Raytheon	RF9601	195-62
	Signetics	N9601	195-70
	SW	SW9601	195-71
9602	AMD	9602C	195-122
		9602M	195-123
	Fairchild	9602	¶ 96-18
		9602C	195-126
		9602M	195-127
	ITT	ITT9602-1	195-132
		ITT9602-5	195-133
	Motorola	MC9602	195-135
	National	DM9602	195-137
	Raytheon	RF9602	195-139
	Signetics	N9602	195-140
		S9602	195-141

Arranged alphanumerically from left to right

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Base Number	Source	Device	Page-Line
9602	SW	SW9602	195-142
9603	Fairchild	9603	¶ 96-18
96101	Fairchild	96101	178-180
		96101C	386- 6
		96101M	386- 7
96106	Fairchild	96106	389-19
9612	Fairchild	9612	¶ 95- 3
		9612C	386-15
		9612EC	386-17
		9612M	386-16
9613	Fairchild	9613	¶ 95- 3
		9613C	390-13
		9613M	390-14
9614	AMD	9614	¶ 91-11
		9614C	386-18
		9614M	386-19
	Fairchild	9614	¶ 95- 3
		9614C	386-20
		9614M	386-21
	ITT	ITT9614-1	386-22
		ITT9614-5	386-23
9615	AMD	9615	¶ 91-11
		9615C	389-45
		9615M	389-46
	Fairchild	9615	¶ 95- 3
		9615C	389-47
		9615M	390- 2
	ITT	ITT9615-1	390- 3
		ITT9615-5	390- 4
9616	AMD	9616C	385-40
	Fairchild	9616	385-41
			¶ 95- 2
			¶ 95- 3
		9616E	385-42
		9616M	385-43
9617	AMD	9617C	388-21
	Fairchild	9617	¶ 95- 2
			¶ 95- 3
		9617C	388-22
9620	AMD	9620	¶ 91-11
		9620C	389-40
		9620M	389-38
	Fairchild	9620C	389-41
		9620M	389-39
9621	AMD	9621	¶ 91-11
		9621C	385-11
		9621M	385-12
	Fairchild	9621	385-13
		9621M	385-14
	Raytheon	RC9621	385-15
		RM9621	385-16
9622	Fairchild	9622C	390-26
		9622M	390-27
	Raytheon	RC9622	390-28
		RM9622	390-29
9624	Fairchild	9624C	198-118
		9624M	198-119
9625	Fairchild	9625C	198-99
		9625M	198-100
9626	Fairchild	9626	392-14
9627	Fairchild	9627	¶ 95- 3
		9627C	390-23
		9627M	390-24
9628	Fairchild	9628	392-18
9634	Fairchild	9634	¶ 95- 3
9635	Fairchild	9635	¶ 95- 3
9636	Fairchild	9636	¶ 95- 3
		9636C	385- 2
		9636M	385- 3
9637	Fairchild	9637	¶ 95- 3
		9637C	389-36
		9637M	389-37
9638	Fairchild	9638	¶ 95- 3
9640	Fairchild	9640	¶ 95- 3
		9640C	201-17
			392-45
		9640M	201-18
			392-40
9641	Fairchild	9641C	201-19
			392-46
		9641M	201-20
			392-41
9642	Fairchild	9642C	393- 2
9642	Fairchild	9642M	392-42
9643	Fairchild	9643	394-94
9644	Fairchild	9644	394-83
9645	Fairchild	9645	394-79
9646	Fairchild	9646	394-22
9647	Fairchild	9647	395-34
9648	Fairchild	9648	395-39
9650	Fairchild	9650	¶ 108- 7
9660	AMI	S9660	524-85
9664	Fairchild	9664AC	381-58
		9664BC	381-59
		9664C	381-57
9665	Fairchild	9665	397-36
			515-35
9666	Fairchild	9666	397-46
			515-36
9667	Fairchild	9667	397-21
			515-37
9668	Fairchild	9668	397-31
			515-38
97C09	National	AM97C09C	369-103
97C10	National	AM97C10C	370- 2
97C11	National	AM97C11C	369-66
97C12	National	AM97C12C	369-78
970	Fairchild	TBA970	513- 8
			526-178
	Signetics	TAA970	512-108
9702	AMD	9702-1	611-56
9709	National	AM9709C	369-104
9710	National	AM9710C	370- 3
9711	National	AM9711C	369-67
9712	National	AM9712C	369-79
980	Signetics	TCA980	512-109
99	**AMI**	**EVK99**	★ **901**
990	Fairchild	TBA990	525-67
	National	TBA990	525-95
	Plessey	TBA990	525-115
	Signetics	TBA990	525-146
	Telefunken	TBA990	525-167
9900	TI	SBP9900	871-132
		TMS9900	★ **1092**
			871-133
			¶ 130- 8
			¶ 130-10
9901	**TI**	**TMS9901**	★ **1094**
			871-149
9902	**TI**	**TMS9902**	★ **1095**
			871-156
9903	**TI**	**TMS9903**	★ **1095**
			871-152
9904	**TI**	**TIM9904**	★ **1096**
			871-138
9905	TI	TIM9905	871-143
9906	TI	TIM9906	871-162
991	Siemens	TAA991	521-40
9920	TI	SBP9920	871-158
9980	**TI**	**TMS9980**	★ **1094**
			871-134
9996	**AMI**	**S9996**	★ **634**
			624-11

¶ Indicates page number in Application Note Directory
★ Indicates additional data is provided on the page noted

PART NUMBER GUIDE

Each IC manufacturer has his own unique method at identifying products, usually through a system of device number prefixes and suffixes. This Part Number Guide is arranged alphabetically by manufacturer and describes each company's part number system. JAN nomenclature is also covered.

Manufacturer	Part Number: Prefix	Part Number: Suffix	Example
ADVANCED MEMORY SYSTEMS	**Classification** IC Circuits - 91 **Sub Category** **0** Custom MOS **1** Bipolar RAM — Sequential Numbers **2** Bipolar — 1-500 ECL **3** Bipolar ROM — 501-999 TTL **4** CMOS **5** SOS **6** PMOS **7** NMOS	**Package** **3A** 16 Pin Flat Pack **3B** 22 Pin Flat Pack **6A** 14 Pin DIP **6B** 16 Pin DIP **6C** 24 Pin DIP **6D** 22 Pin DIP **6E** 18 Pin DIP **P** Plastic	**Device: AMS 6003** Prefix: 91 — Classification Device: 6 003 — Sub-Category Suffix: 11 — Test Spec Suffix: 6DP — Package Code
ADVANCED MICRO DEVICES Note: Alternate source devices follow original manufacturer's part number and marking system.	**Functional Group** **25** MSI **26** Computer Interface **27** Bipolar Memory **28** MOS **90** MOS **91** MOS **Type** **L** Low Power **S** Schottky **LS** Low Power Schottky **(Blank)** Standard	**Package** **D** Hermetic DIP **P** Molded **F** Flat **X** Dice **Temperature Range** **C** Commercial **M** Military	Prefix: AM25 — Functional Group Device: S — Type Device: 05 — Device Number Suffix: D — Package Suffix: M — Temperature Range
AMERICAN MICROSYSTEMS	**Family** **S** Standard	**Package Type** **1** Plastic **2** Cer-DIP **3** SLAM **4** Ceramic (Three Layer) **5** TO Type **Package/Pins** **C** 22 Pin Plastic or Cer-DIP **D** 14 Pin Plastic or Ceramic **F** 12 Pin TO **H** 16 Pin Cer-DIP, SLAM, or Ceramic **I** 28 Pin Cer-DIP or SLAM **L** 24 Pin Cer-DIP or SLAM **M** 40 Pin SLAM **P** 18 Pin Plastic or Cer-DIP **T** 40 Pin Plastic **U** 16 Pin Plastic **W** 24 Pin Plastic **Z** 28 Pin Plastic	Prefix: S — Family Device: 1103X — Version Suffix: 2 — Package Type Suffix: P — Number of Pins
ANALOG DEVICES	**AD** Analog Devices	**Temperature Range** **J,K,L** Commercial Grade **S,T** Military Grade **Package** **DN** Ceramic DIP **D** 8 Pin Ceramic DIP **E** 14 Lead Plastic DIP **F** Ceramic Flatpack **H** TO-5 type Can **N** Plastic DIP	Prefix: AD Device: 7516 Suffix: JN — Temperature Range Suffix: JN — Package
BECKMAN INSTRUMENTS	**Family (Model Number)** 801-809, 851-859 Voltage Regulators 811-816, 862, 863, Ladder Networks 822, 823, 833, 866 Amplifiers 840 Voltage References 845-872, 877 D/A Converters 873, 876 A/D Converters 882, 883 Active Filters	**Package Type** **M** Metal **C** Ceramic **G** Glass **Version (Function)** **I** Current **V** Voltage **Accuracy Level** **D1** Best level **D2**	Prefix: 877- — Family Device: 85 — Model Number Device: MV- — Package Type Suffix: — Version (Function) Suffix: D1 — Accuracy Level

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Manufacturer	Part Number: Prefix	Part Number: Suffix	Example

BURR-BROWN

Temperature
H, J, K, L = 0°C to +70°C
R, S, T = −55°C to +125°C
A, B, C = −25°C to +85°

Package
M = Metal
P = Plastic
Q = Mil-883 screening

Prefix	Device	Suffix
	3532	AMQ

Temperature Range
Package
Mil-883 Screening

COLLINS

Package
1 Ceramic DIP
2 Flatpack
3 Plastic DIP

Temperature
1 −55°C to 125°C
2 −25°C to 85°C
3 0°C to 70°C

Prefix	Device	Suffix
CRC	1504	-1 -2

Package
Temperature Range

DATEL

Family
ADC A/D Converters
AM Amplifiers
SHM Sample-Hold

Package
1 14 Pin DIP
2 TO-99

Temperature
C 0°C to 70°C
M −55°C to 125°C

Prefix	Device	Suffix
AM	490	2 A

Package
Selection

DAC	HY12B	C

Temperature

ELECTRONIC ARRAYS

Family
10 Static Shift Register
12 Dynamic Shift Register
15 N Channel RAM
20 Keyboard Encoder
3X Dynamic ROM
4X Static ROM

Package
D Hermetic DIP
F Flat Pack
P Molded DIP
T TO-Can
X Dice

Temperature Range
C 0°C to 70°C
I −55°C to 85°C
L −55°C to 100°C
M −55°C to 125°C
X Other

Prefix	Device	Suffix
EA	1500A	DM

Family
Package
Temperature Range

Note: Alternate source devices follow original manufacturer's part number and marking system.

EMM/SEMI

A. Semi Product

Variation
U Standard
A Variation A
B Variation B
C Variation C, etc.

Temperature Range
C 0°C to 70°C
S −35°C to 85°C
M −55°C to 125°C

Package
D Dice
C Dual in Line, Ceramic 22 pin
P Dual in Line, Plastic, 22 pin
F Flat Package, Ceramic
S Special Packages
E "Pill Package" 22 pin leadless

Prefix	Device	Suffix
M	4200	UCC

Variation
Temperature Range
Package

B. General Instrument
Second Source Marking

Family
RO ROM
RA RAM
CP Microprocessor

Prefix	Device
SEMI	RA-3-4256

Family
Package

EXAR INTEGRATED SYSTEMS

XR Exar

Grade
C Commercial
M Military (Ceramic package and −55°C to 125°C)
( ) The absence of C or M indicates a commercial part with tighter specs

Package
K TO-66 (Mod)
P Plastic
N Ceramic (Dice available)
T TO-99, TO-100, TO-101 Metal can

Prefix	Device	Suffix
XR	567	CP

Grade
Package

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Manufacturer	Part Number: Prefix	Part Number: Suffix	Example

FAIRCHILD

Prefix
- **F** Fairchild
- **SH** Hybrid
- **μA** Linear

Package
- **C** Chip (Dice)
- **D** Ceramic DIP
- **E** Plastic Can
- **F** Flat Pac
- **H** Metal Can
- **J** Metal Power Package (TO-66)
- **K** Metal Power Package (TO-3)
- **P** Plastic DIP
- **R** Ceramic Mini DIP
- **T** Plastic Mini DIP
- **U** Power Package (Molded, TO-220)
- **W** Plastic TO-92

Temperature — Check Device Data for Specific Values
- **C** 0°C to 70°C/75°C (CMOS −40°C to 85°C)
- **L** MOS −55°C to 85°C Hybrid −20°C to 85°C
- **M** −55°C to 85°C/125°C

Example

Prefix	Device	Suffix
μA	741	AHM

Electrical Class (if used)
Package
Temperature

Alternate source devices may follow original manufacturer's part number and marking systems.

GENERAL INSTRUMENT

Designation
- **CU** Array
- **AY** Array
- **DL** Shift Register Dynamic ≥ 50 Bits
- **DS** Shift Register Dynamic < 50 Bits
- **LC** Linear Circuit
- **LG** Logic Cells
- **MEN** N an P Channel FETs
- **MU** Multiplexer
- **RA** RAM
- **RO** ROM
- **SL** Shift Register Static ≥ 50 Bits
- **SS** Shift Register Static < 50 Bits

Temperature and Processing
- **0** MTOS −55°C to 85°C
- **1** MTOS 0°C to 70°C
- **4** N Channel
- **5** MTNS 0°C to 70°C
- **6** −55°C to 125°C
- **7** MTNS
- **8** Silicon Gate −55°C to 125°C
- **9** Silicon Gate 0°C to 70°C

Description

multiplexers
- **WX** Indicates Typical $R_{ds}(on)$ in hundred ohms steps:
  - 01 ≤ 100 ohms
  - 02 ≤ 200 ohms
  - 03 ≤ 300 ohms, etc.
- **YZ** Total Number of Channels

Custom
- Custom Number Assigned

ROM/RAM
- **WXYZ** Total Number of Bits

Shift Registers
- **W** Indicates the number of redundant configurations:
  - 1 Single 3 Triple
  - 2 Dual 4 Quad, etc.
- **XYZ** Total number of bits per configuration

Arrays/Linear/Logic
- **WXYZ** Arbitrary Number Assigned

Package Identification (Not Marked on Pkg.)
- **01** Dice
- **12** 8 Lead DIP
- **14** TO-5 4 Lead
- **15** TO-78 8 Lead
- **16** TO-5 8 Lead
- **17** TO-5 8 Lead High Profile
- **21** TO-5 10 Lead
- **22** TO-5 10 Lead Isolated
- **23** TO-100 10 Lead
- **29** 24 Lead Plastic DIP
- **30** 14 Lead Plastic DIP
- **31** 16 Lead Plastic DIP
- **32** 24 Lead Plastic DIP
- **33** 40 Lead Plastic DIP
- **35** 36 Lead Plastic Flat Pack
- **51** TO-8 12 Lead Low Profile
- **55** 16 Lead DIP
- **60** 10 Lead Flat Pack
- **61** 14 Lead Flat Pack
- **62** 16 Lead Flat Pack
- **63** 20 Lead Flat Pack
- **64** 24 Lead Flat Pack
- **65** 40 Lead Flat Pack
- **66** 36 Lead
- **68** 44 Lead Flat Pack
- **69** 14 Lead DIP
- **71** 16 Lead DIP
- **72** 24 Lead DIP .6 MIL Centers
- **73** 24 Lead DIP .5 MIL Centers
- **74** 40 Lead DIP .6 MIL Centers
- **75** 40 Lead DIP 1.05 MIL Centers
- **76** 28 Lead DIP
- **77** 18 Lead DIP
- **79** 24 Lead DIP .6 MIL Centers
- **80** 14 Lead Ceramic RIP
- **81** 16 Lead Ceramic DIP

Example

Prefix	Device	Suffix
RO-6	WXYZ	(XX)

Desig-nation
Temp. & Processing
Description
Package Identification

HARRIS

Family
- **A** Analog
- **D** Digital
- **I** Interface
- **M** Memory

Package
- **1** DIP
- **2** TO-5 Type
- **7** Mini DIP
- **9** Flat Pack
- **0** Chip Form

Exceptions
- **HPROMX-0152-X**
- **HPROMX-1024-X**
- **HPROMX-8256-X**

Temperature Range
- **2** −55°C to 125°C
- **4** −25°C to 85°C
- **5** 0° to 75°C
- **6** 100½ 25°C Probe (Dice only)
- **8** Dash 8 Program, MIL-STD-883, Class B Example: HA-2700-8
- **9** −40°C to 85° (4000 Series CMOS)

Exceptions

The 54C/74C CMOS Family temperature designation is contained in the Part Number

Example:

54CXX −55°C to 125°C
74CXX 0°C to 70°C

Example

Prefix	Device	Suffix
H M I	7620	5

Family
Package
Temperature Range

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HUGHES AIRCRAFT

Prefix
- **H** Standard
- **S** Special

Family
- **CTR** Counter
- **CUS** Custom
- **DSR** Dynamic Shift Register
- **SSR** Static Shift Register
- **SUB** Subsystem
- **MUL** Multiple
- **DIG** Discrete Insulated Gate
- **DGP** Discrete General Purpose
- **DSW** Discrete Switch
- **PLA** Programmable Logic Array

Package
- **D** Cerdip or Ceramic DIP
- **F** Flat Pack
- **P** Plastic DIP
- **T** TO

Prefix	Device	Suffix
H CTR	0320	D

Family — Package

ITT SEMICONDUCTORS

ITT
SAK
SAJ
SAY
TAA
TBA
TCA
TDA

Temperature Range
- **1** −55°C to 125°C
- **5** 0°C to 70°C (0°C to 75°C Digital)

Package
- **B** Flat Package
- **C** TO-5 Style
- **D** Ceramic DIP
- **N** Plastic DIP

Prefix	Device	Suffix
ITT	709A	1D

Temperature Range — Package

INTEL

Package
- **B** CerDIP (Ceramic or window lid) (Hermetic)
- **C** Ceramic (Metal lid) DIP (Hermetic)
- **D** CerDIP (Glass Seal) DIP (Hermetic)
- **P** Plastic DIP
- **M** Metal Can Package (Hermetic)

On military temperature devices /B indicates MIL-STD-883 level B processing; /C, level C processing.

Prefix	Device	Suffix
P	5101	L
C	8080	A
MD	3601	/C

Military Temp. — Package — Suffix

INTERNATIONAL MICROCIRCUITS

- **MM** Master MOS Array
- **SCC** Special Custom Circuit

Family
- **1** Small Chip
- **2** Special Size
- **3** Medium Chip
- **6** Large Chip

Package
- **C** Ceramic
- **P** Plastic DIP
- **S** Special

Prefix			Suffix
MM	6	013	B-P 28

Family — Metal Option — Change Level — Package — No. of Pins

INTERSIL

A. Hybrid

Temperature
- **1** −55°C to 125°C
- **4** 0°C to 70°C

Package (see last example)

Pins (see last example)

Prefix	Device	Suffix
DG 1	26A	D D

Analog Gate — Temperature — Package — No. of Pins

Characteristics
- **5** Analog
- **7** Digital
- **9** Interface

General Type
- **0** Gates
- **1** Amplifiers

Package (see last example)

Pins (see last example)

Prefix			Device	Suffix
IH	5	0	01	P A

Intersil Hybrid — Characteristics — General Type — Package — No. of Pins

B. Linear, Low Power, Watch & Clock Circuits

Circuits
- **L** Linear
- **CM** Watch, Clock

Temperature
- **C** Commercial (0°C to 70°C)
- **I** Industrial (−22°C to 70°C)
- **M** Military (−55°C to 125°C)

Package (see last example)

Pins (see last example)

Prefix	Device	Suffix
IC X	8001	C T Z

Intersil Circuit — Package — Temperature — No. of Pins

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Manufacturer	Part Number: Prefix	Part Number: Suffix	Example

Intersil (cont)

C. Memory Circuits

Process
- **5** Bipolar
- **6** CMOS
- **7** MOS

General Type
- **0 to 4** Digital
- **5** Random Access Memory (RAM)
- **6** Programmable Read Only Memory (PROM)
- **7** Shift Register

Temperature
- **C** Commercial (0°C to 75°C)
- **M** Military (−55°C to 125°C)
- **N** Reduced Military (−20°C to 125°C)

Package
- **D** Dual-In-Line Package Ceramic
- **E** Small TO-8 Type
- **F** Flat Package, Ceramic
- **G** TO-8 Type
- **H** Flat Package, Silicon
- **I** 16 Pin DIP (0.6 x 0.7 Lead Space)
- **J** Dual-In-Line Cerdip
- **L** Leadless Ceramic
- **P** Dual-In-Line Package, Plastic
- **T** TO-5 Type

Pins (No. of)

H	6	**F**	22
A	8	**G**	24
B	10	**I**	28
C	12	**J**	32
D	14	**K**	36
E	16	**L**	40
N	18		

- **V** 8, .230" Pin Circle
- **W** 10, .230" Pin Circle
- **Y** 8, No. 4 Lead Connected to Case
- **Z** 10, No. 5 Lead Connected to Case

Example

Prefix					Suffix		
I	M	7	6	01	XX	C	D	E

- I — Intersil
- M — Memory Circuit
- 7 — Process
- 6 — General Type
- 01 — ROM Pattern Identification (Applicable to ROM only)
- XX — ROM Pattern Identification (Applicable to ROM only)
- C — Temperature
- D — Package
- E — No. of Pins

JAN NOMENCLATURE

J / **JAN** } Qualified Device

M38510 Military Designation

Device

The "Slash" numbering signifies the specification and specifies the device type. See Military Parts Directory.

Note: The J or JAN prefix is very important if it is not there it is not a JAN device

Device Class
- **A** Missles and Manned Spacecraft
- **B** General Military
- **C** Less Critical Military Applications

Case Outline
- **A** ¼" x ¼" Flat Pack, 14-Pin
- **B** ⅛" x ¼" Flat Pack, 14-Pin
- **C** ¼" x ¾" Dual-In-Line, 14-Pin
- **D** ¼" x ⅜" Flat Pack, 14-Pin
- **E** ¼" x ¾" Dual-In-Line, 16-Pin
- **F** ¼" x ⅜" Flat Pack, 16-Pin
- **G** 8-Lead Can
- **H** ¼" x ¼" Flat Pack, 10-Lead
- **I** 10-Lead Can
- **J** ½" x 1¼" Dual-In-Line, 24-Pin
- **K** ⅜" x ½" Flat Pack, 24-Pin
- **L** ⅜" x ½" Flat Pack, 24-Pin
- **Z** ¼" x ⅜" Flat Pack, 24-Pin

Lead Finish
- **A** Kovar or Alloy 42, with Hot Solder Dip
- **B** Kovar or Alloy 42, with Bright Acid Tin Plate
- **C** Kovar or Alloy 42, with Gold Plate

Example

Prefix	Device	Suffix		
JM38510	/XXXXX	B	C	B

- B — Device Class
- C — Case Outline
- B — Lead Finish

LITHIC SYSTEMS

Device Type
- **LA** Array
- **LP** Proprietary
- **LS** Second Source

(Proprietary Devices)
- **A** Premium
- **B** Super Premium
- **C** Commercial
- **E** Entertainment

Example

Prefix	Device	Suffix
LP	2000	C

LP — Device Type

MICRO NETWORKS

MN Micro Networks

Temperature Range
- **(No suffix)** 0°C to 70°C
- **E** −55°C to 85°C
- **H** −55°C to 125°C
- **B** Processing to 883A Method 5004.2

Example

Prefix	Device	Suffix	
MN	3000	H	B

- H — Temperature Range
- B — Processing

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Manufacturer	Part Number: Prefix	Part Number: Suffix	Example

MITEL SEMICONDUCTOR

Description:
- **MA** Linear
- **MD** Digital
- **MT** Telecom.
- **MS** Custom
- **SIL** Siltek CMOS

Version:
- **A** Modified Version, Unilaterally Interchangeable with Unlettered Version.
- **B** Unilaterally Interchangeable with A and Unlettered Versions.

Package Style, Temperature Range:
- **C** Frit Seal Ceramic DIP, −40°C to 85°C.
- **D** White Ceramic DIP, −55°C to 125°C.
- **E** Plastic DIP, −40°C to 85°C.
- **F** Frit Seal Ceramic DIP, −55°C to 125°C.
- **H** Plated Chip, −40°C to 85°C.
- **I** Plated Chip, −55°C to 125°C.
- **J** Ceramic DIP, 24-Leads.
- **K** Ceramic, Flat Pack.
- **L** Ceramic DIP, 28-Leads.
- **M** Ceramic DIP, 40-Leads.
- **N** Plastic DIP, 24-Leads.
- **O** Plastic DIP, 28-Leads.
- **S** Plastic DIP, 40-Leads.
- **W** Wafer, probe tested.

MIL Process Option:
- **B** MIL-883, Class C Plus 168 Hr. Burn-In.
- **R** High-Reliability Plastic DIP.

Device: SIL4098B

Prefix	Device	Suffix
SIL	4098	BER

Version
Package/Temperature
MIL Process Option

MITSUBISHI

M Mitsubishi

Temperature
- **5** Industrial/Commercial
- **9** Military

Series

1 Linear Circuit	**45** TTL
17 Linear Circuit	**46** TTL
3 TTL	**47** TTL
32 TTL	**81** MOS
33 TTL	**85** MOS
43 TTL	**86** MOS
44 TTL	**9** DTL

Package
- **K** Glass-sealed ceramic DIL
- **K-1** 16-pin
- **P** Plastic-molded DIL
- **P-1** 14-pin (JEDEC TO-116)
- **P-3** 16-pin
- **P-5** 24-pin
- **P-11** 8-pin
- **S** Metal-sealed ceramic DIL
- **S-2** Metal-sealed ceramic DIL
- **Y** Can-sealed glass metal
- **Y-1** 10-pin (modified JEDEC TO-3)

Prefix	Device	Suffix
M	5 32 90	P

Temperature
Series
Package

MONOLITHIC MEMORIES

Temperature
- **5** Military TTL
- **6** Commercial TTL

Type
- **0** Character Generator
- **2** ROM
- **3** PROM
- **5** RAM
- **7** Computer Logic

Package
- **D** Ceramic
- **F** Flat Pack
- **J** CERDIP
- **N** Plastic
- **W** Ceramic

Prefix	Device	Suffix
5	2 05	D

Temperature
Type
Package

MOSTEK

MK Mostek

Package
- **E** Leadless Chip Carrier
- **F** Flat Ceramic Package
- **K** Tin Plated Frit-Sealed Ceramic
- **M** Plastic Flat Package
- **N** Plastic Dual In-line
- **P** Ceramic Dual In-line
- **T** Ceramic Dual In-line with transparent lid

Prefix	Device	Suffix
MK	4096	P

Package

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MOTOROLA

Description
- **MC** Packaged Integrated Circuits
- **MCB** Packaged Beam-lead Integrated Circuits. (Followed by F suffix when in flat pack.)
- **MCBC** Beam-lead Integrated Circuit Chips
- **MCC** Unencapsulated Integrated Circuit Chips
- **MCCF** Flip-Chip Linear Integrated Circuits
- **MCE** Dielectrically Isolated Integrated Circuits
- **MCM** Integrated Circuit Memories
- **MLM** Pin-for-pin equivalent to Linear Integrated Circuits made by National Semiconductor.

Package
- **F** Flat Ceramic Package
- **G** Metal Can Package (TO-5 types)
- **K** Metal Power Package (TO-3 types)
- **L** Ceramic Dual-In-Line Case
- **P** Plastic Package
- **PQ** IC's Packaged in Staggered-Lead Plastic DIP Packages
- **R** Metal Power Packages (TO-66 types)
- **U** Ceramic Package

Prefix	Device	Suffix
MC	14510	L

Prefix: Description; Suffix: Package

NATIONAL

DEVICE NUMBER (for Digital Devices):
CDXXXX--CMOS — C suffix −40°C to 85°C, M suffix −55°C to 125°C.
DM54XX — All numbers beginning with 5 denote −55°C to 125°C temperature operation.
DM74XX — If the "74" is indicated, the operating temperature is 0°C to 70°C.
DM7XXX — All other numbers beginning with 7 (besides the "74" shown above) are NSC proprietary products and a 7 here indicates −55°C to 125°C.
DM8XXX — All numbers beginning with 8 denote 0°C to 70°C temperature operation.

Description
- **AH** Analog Hybrid
- **AM** Analog Monolithic
- **DC** CMOS
- **DH** Digital Hybrid
- **DM** Digital Monolithic
- **DS** Digital Special
- **LF** Linear FET Monolithic
- **LH** Linear Hybrid
- **LM** Linear Monolithic
- **LX** Transducer
- **MH** MOS Hybrid
- **MM** MOS Monolithic

Linear Devices
With proprietary linear circuits, a 1-2-3 numbering system is employed. The 1 denotes a Military temperature range device (−55°C to 125°C), the 2 denotes an Industrial device (−25°C to 85°C), and the 3 denotes a Commercial device (0°C to 70°C). i.e. LM101/LM201/LM301. Exception to this are the LM1800 Series; some hybrid circuits which employ a "C" suffix; and second-source products which follow the original manufacturers numbering system.

Characteristics
- **A** Improved Electrical Specs
- **C** Reduced Temperature Range

Package
- **D** Glass/Metal DIP
- **F** Flat Pack (0.25" wide)
- **G** TO-8 (12 lead) Metal Can
- **H** TO-5 (multi-lead) Metal Can
- **J** Glass/Glass
- **K** TO 13 Power Pack
- **M** Wide Trak Power Pack
- **N** Molded DIP
- **P** TO-202 Plastic Power Pack
- **R** Low Temperature Ceramic Pack
- **S** 14 Lead Power Pack SGS Power Pack
- **T** TO-220 Plastic Power Pack
- **W** Flat Pack (0.275" wide)
- **Z** TO-92

Prefix	Device	Suffix
LM	101	A F

Prefix: Characteristics; Suffix: Package

NEC

μP Micropackage
Family
- **A** Discrete
- **B** Digital Bipolar
- **C** Linear
- **D** Digital CMOS

Package
- **C** Plastic
- **D** Ceramic

Prefix			Suffix
μP	F	xxxxx	P S

Prefix: Family; Package; Suffix: Modification

NITRON

Description
- **NC** Packaged IC's (non-memory)
- **NCM** Packaged Memory IC's
- **NIT** Memory Modules

Prefix	Device	Suffix
NC	7010	

Prefix: Description

NORTEC

NE Nortec Electronics
NE 6003BZD
NE 1103-146D

Electrical Selections
- **11**
- **BZ**
- **146**
- **etc.**

Electrical Selections

Package
- **D** Ceramic DIP
- **F** Flatpack
- **H** Metal Can
- **J** CerDIP
- **N** Molded DIP
- **P** 8-Pin DIP
- **Y** Dice

Prefix	Device	Suffix
NE	6003	11 D

Prefix: Electrical Selections; Suffix: Package

PANASONIC

Description
- **AN** Analog
- **DN** Digital Bipolar
- **J** Development Type
- **MN** MOS

Prefix	Device
DN	830

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Manufacturer	Part Number: Prefix	Part Number: Suffix	Example

PLESSEY

Description

- **ML** MOS Linear (w/gate protection)
- **MP** MOS Digital
- **MT** MOS Linear (without gate protection)
- **NOM** MNOS Memory Elements and Arrays
- **SAA, SBA** Alternate Sourced Consumer Devices
- **SL** Bipolar Linear
- **SP** Bipolar Digital

Characteristics

- **A-D** Electrical/Temperature Variations

Package

- **E** DIP
- **F** Flatpack
- **P** Power
- **Q** Quad In-Line
- **S** Stud
- **T** TO-5 and TO-18

Prefix	Device	Suffix
	421	A T

Elec/Temp — A
Package — T

POWER MONOLITHICS

- **PMD** Discrete
- **LAS** Regulator

Prefix	Device	
LAS	14	12

Voltage — 12

PRECISION MONOLITHICS

Description

- **AD** Analog to Digital Converter
- **CMP** Voltage Comparator
- **DAC** Digital to Analog Converter
- **MAT** Matched Transistors
- **OP** Operational Amplifier
- **PM** Second Source Devices
- **REF** Voltage Reference
- **SSS** Second Source Devices

Package (Last Alphabetical Character)

- **H** 6-Pin TO-78
- **J** 8-Pin TO-99
- **K** 10-Pin TO-100
- **L** 10-Pin Flatpack
- **M** 14-Pin Flatpack
- **N** 24-Pin Flatpack
- **Q** 16-Pin Hermetic DIP
- **W** 40-Pin Hermetic DIP — .600" Centers
- **X** 18-Pin Hermetic DIP
- **Y** 14-Pin Hermetic DIP

Prefix	Device	Suffix
DAC	01	CY

Package — CY

RAYTHEON SEMICONDUCTOR

Temperature

- **LH1, LM1** −55°C to 125°C
- **LH2, LM2** −25°C to 85°C
- **LH3, LM3** 0°C to 70°C
- **RC** 0°C to 70°C
- **RM** −55°C to 125°C
- **RV** −40°C to 85°C
- **54** −55°C to 125°C
- **74** 0°C to 70°C
- **MAX-xxxx-2** −55°C to 125°C
- **MAX-xxxx-5** 0° to 70°C

Package

Most Devices

- **BL** Beam Lead Chip
- **BLB** BL Chip, Military Visual
- **CG** Gold-Backed Chip
- **CH** 14-Pin Plastic DIP
- **DB** 14-Pin Plastic DIP
- **DC** 14-Pin Ceramic DIP
- **DD** 16-Pin Ceramic DIP
- **DN** 8-Pin Plastic DIP
- **G** 10-Pin Flatpack, 1/4 "—9/64" (Linears Only)
- **J** 14-Pin Glass/Metal Flatpack
- **L** 16-Pin Glass/Metal Flatpack
- **LK** TO-3 Power Pack
- **M** 16-Pin Glass/Metal DIP
- **MP** 16-Pin Plastic DIP
- **N** 24-Pin Glass/Metal Flatpack
- **Q** 10-Pin Flatpack, 1/4" x 1/4"
- **R** 24-Pin Ceramic DIP
- **T** 3, 8, 10 or 12-Pin TO-5 Can
- **TK** 9-Pin TO-66 Power Pack
- **Y** TO-220 Plastic Power Pack

LH, LM Series

- **F** Flat Pack (¼" Wide)
- **H** 3, 8 or 10-Pin TO-5 Can
- **K** TO-3 Power Pack
- **N** Plastic DIP

HA Series

- **HA1** 14-Pin Ceramic DIP
- **HA3** 14-Pin Plastic DIP

Prefix	Device	Suffix
54	153	DD
RC	4136	DB
LM	118	H
HA1	4741	5

Temperature — HA1
Package — 5

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Manufacturer	Part Number: Prefix	Part Number: Suffix	Example

RCA

Description

- **CA** Linear IC's
- **CD** Digital IC's
- **CDP** Microprocessor IC's
- **MW** MOS IC's
- **CDPS** SOS Versions
- **MWS** SOS Versions

Version

- **A** Modified Version, Unilaterally Interchangeable with Prototype
- **B** Modified Version, Unilaterally Interchangeable with A Version, and with Prototype
- **C** Modified Version, Unilaterally Interchangeable with B, A, and Prototype Versions

Package

- **D** White Ceramic DIP
- **E** Plastic DIP
- **F** Ceramic DIP, frit seal
- **G** Hermetic Chip in Plastic Package
- **H** Chip
- **K** Ceramic Flat Package
- **L** Beam-Lead Device
- **Q** Quad-In-Line Plastic Package
- **S** TO-5 Package with DIL-CAN
- **T** TO-5 Package
- **X** Ceramic DIP, frit seal

Prefix	Device	Suffix
CD	4070	BD

Version: BD
Package: BD

RETICON

- **RA** Area Array
- **RL** Linear Array
- **SAD** Serial Analog Delay
- **SAM** Serial Analog Memory
- **SAP** Serial Analog Processor
- **TAD** Tapped Analog Delay

Code

- No. of columns and lines
- No. of elements
- No. of storage elements
- No. of storage elements
- No. of storage elements
- No. of Taps

Prefix	Device	Suffix
RA	50x50	A
RL	1024	C
TAD	12	

Code: 12
Revision: C

SCIENTIFIC MICRO SYSTEMS

SMS Scientific Micro-Systems

Prefix	Device	Suffix
SMS	300	–x

Version: –x

SGS-ATES SEMICONDUCTOR

(Prefixes assigned by the European Association "PRO ELECTRON")

- **H** High Level Logic
- **HB** CMOS
- **L** Linear Professional
- **M** MOS
- **TAA** Linear Consumer
- **TBA** Linear Consumer
- **TCA** Linear Consumer
- **TDA** Linear Consumer

Prefix	Device
TDA	1200

SIGNETICS

Temperature

- **LM** Linear IC-Alternate Source
- **N or None** 0°C to 70°C
- **N8** 0°C to 75°C
- **S(E)** –55°C to 125°C
- **SA** –40°C to 85°C
- **5400 Series** –55°C to 125°C
- **7400 Series** 0°C to 70°C

Package

- **N** 8, 14, 16, 18, 22, 24, 28, 40 Lead DIL Plastic
- **F** 14, 16, 18, 22, 24 Lead Ceramic DIP
- **I** 8, 14, 16, 18, 22, 24, 28, 40, 50 Lead CERAMIC DIP Side Brazed
- **W** 10, 14, 16, 24 Lead Ceramic Flat Pack
- **Q** 10, 14, 16,24 Lead Ceramic Flat—Bottom Brazed
- **K** 10 Lead TO-100 Header, Low Profile
- **T** 10 Lead TO-100 Header Tall Can
- **L** 8 Lead TO-99 Header
- **DA** TO-3 Solid Header, Can
- **DB** TO-5 Solid Header, Can
- **R** 16, 18, 24, 28, 40 Lead Beryllia Flat Pack

Prefix	Device	Suffix
	74123	N
N	8X02	N

Temperature: N
Package: N

SILICON GENERAL

SG Silicon General

Characteristics

- **A** Improved Electrical Spec.
- **C** Reduced Temperature Range

Package

- **F** Flat Pack
- **J** 14, 16-Pin DIP (Cerdip)
- **K** TO-3 Power Pack
- **M** 8-Pin Plastic DIP
- **N** 14, 16-Pin Plastic DIP
- **T** TO-5 Metal Can (TO-39/99/100/101)
- **Y** 8-Pin DIP (Cerdip)

Prefix	Device	Suffix
SG	1524	J
SG	108A	T

Characteristics: 108A
Package: T

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SILICONIX

Part Number

Prefix

Description
- **D** Driver for FET Switch
- **DF** Digital LSI
- **DGM** Driver with FET Switches (Monolithic Version of Hybrid Device)
- **G** Multi-Channel FET Switches
- **H** High Voltage (28v) Logic
- **L** Linear IC
- **LD** A/D Converter
- **LH** Hybrid Linear IC (2nd Source)
- **LM** Linear IC (2nd Source)
- **Si** 2nd Source Part
- **S** Power Logic Switch

Suffix

Temperature
- **A** −55°C to 125°C
- **B** −20°C to 85°C
- **C** 0°C to 70°C

Package
- **A** Metal Can
- **F** Flatpack
- **J** Plastic DIP
- **K** Ceramic DIP
- **L** Flatpack
- **P** Hermetic DIP
- **R** Hermetic DIP

MIL Process Option

MIL-883, Class A
- **2** MIL-883, Class B
- **3** MIL-883, Class C
- **4** In-House Screening Plus 168 Hr. Burn-In

Example

Prefix	Device	Suffix
DG	200	BA-X

Temperature
Package
MIL Process Option

SMC MICROSYSTEMS

Prefix

Family
- **CG** Character Generator
- **COM** Communications
- **KR** Keyboard Encoding

Suffix

Package
- **P** Plastic
- **C** Ceramic

Temperature
- **T** −25°C to 85°C
- **(Blank)** 0°C to 70°C

An H in the Suffix Indicates High Speed

Example

Prefix	Device	Suffix
COM	2502	P

Family
Package
Temperature Range

SOLID STATE SCIENTIFIC

Prefix

Reliability
- **A** MIL 883-A
- **B** MIL 883-B
- **C** MIL 883-C
- **S** Standard

Other Letters
- **CM** CMOS
- **C** Complementary
- **L** Logic
- **M** Memory

Suffix

Process
- **A** AL Gate Bulk
- **B** High Voltage AL Gate
- **S** Silicon on Sapphire

Package
- **C** Ceramic DIP
- **D** Ceramic DIP
- **E** Epoxy DIP
- **H** Chip
- **F** Flat Pack
- **T** TO5

Example

Prefix	Device	Suffix
SCL	4000	AE+

Reliability
Process
Package
Special Screening

SOLITRON

Prefix

CM CMOS

Suffix

Package Style, Temperature Range
- **AD** Ceramic DIP, −55°C to 125°C
- **AE** Epoxy Encapsulated DIP, −40°C to 85°C
- **AF** CerDIP, −55°C to 125°C

Example

Prefix	Device	Suffix
CM	4000	AD

Package/Temperature

SPRAGUE ELECTRIC

A. UC Series
UD Series
UL Series

Prefix

Family
- **C** CMOS
- **D** Display Drivers
- **L** Linear Circuits

Temperature
- **N** Limited Temperature Range, −25°C to 70°C typical
- **S** Extended Temperature Range

Suffix

Package
- **A** Plastic DIP
- **B** Plastic DIP with heat sink tabs
- **C** Chip
- **D** TO-99
- **E** 8-Pin Plastic DIP with pins 1, 4, 5, & 8 only
- **F** TO-86 or 30 Lead Flat Package
- **G** TO-99
- **H** 91-Pin Hermetic DIP
- **J** TO-87
- **K** TO-100
- **L** TO-100
- **M** 8-Pin Plastic DIP
- **N** 14-Pin Plastic Quad-In-Line
- **P** Batwing DIP
- **Q** Batwing Quad-In-Line
- **R** 8-Lead DIP with Unformed Leads
- **S** 4-Pin SIP
- **T** 3-Pin SIP
- **W** TO-100 with Miniature Tube Base Adapter

Example

Prefix	Device	Suffix
ULN	2111	A

Family
Temperature
Package

Prefix

Package
- **C** Hermetic Flatpack
- **D** Hermetic Dip
- **P** Plastic DIP

Example

Prefix	Device
UHP	400

Package

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Manufacturer	Part Number: Prefix	Part Number: Suffix	Example

STEWART-WARNER

Prefix: **SW** Stewart-Warner

Series
DTL 7XX to 93X

Package
2M Commerical (0°C to 70°C) Plastic DIP
2P Commercial (0°C to 70°C) Ceramic DIP
1P Military (−55°C to 125°C) Ceramic DIP
1F Military (−55°C to 125°C) Ceramic Flat Pack

Series — **DTL** 18XX to 19XX
Package — **M** Plastic, **P** Ceramic, **F** Flat Pack

Series — **TTL** 74XX to 9XXX
Package — **N, PC** Plastic, **J, DC** Ceramic

Series — **CMOS** 4XXX
Package — **AE** Plastic/Epoxy B (−40°C to 85°C

Prefix	Device	Suffix
SW	7495	N

Series — Package/Temperature

TELEDYNE SEMICONDUCTOR

For alternate source devices, the original manufacturer's part number and marking system is used.

Temperature/Electrical
A −55°C to 125°C, Selected Electrical Performance (HiNIL −30°C to 70°C) 15V Supply
B −55°C to 125°C, Premium Electrical Performance
C 0°C to 70°C, Industrial Electrical Performance (HiNIL −30°C to 85°C); 12V supply
M −55°C to 125°C

Package
E Metal Can
H Flat Pack
J Plastic Dip
L CerDIP
N Ceramic DIP
P Plastic Mini DIP, 8 Lead
Y Dice

Device	Suffix
709	BE

Temperature/Electrical — Package

TEXAS INSTRUMENTS

RSN Radiation Hardened Circuit
SBP Pipolar Processor
SN Standard Prefix
SNM High Reliability, Level I
SNA High Reliability, Level II
SNC High Reliability, Level III
SNH High Reliability, Level IV
TL Linear
TMS MOS

Temperature (Most Devices)
52 Series −55°C to 125°C
54 Series −55°C to 125°C
55 Series −55°C to 125°C
62 Series −25°C to 85°C
72 Series 0°C to 70°C
74 Series 0°C to 70°C
75 Series 0°C to 70°C
TF Series −40°C to 85°C
TP Series −55°C to 125°C
TMS C Series −125°C to 85°C
TMS L Series 0°C to 70°C
TMS R Series −55°C to 85°C

Package
FA Flat Package
J Ceramic Flat Package
JA DIP
JB DIP
JP DIP
L Metal Can
LA Metal Can
N Plastic DIP
ND Plastic DIP with Tab
P Plastic DIP
RA Flat Package
SB Flat Package
T Metal Flat Package
W Ceramic Flat Package

A.

Prefix	Device	Suffix
SN 74	S188	J

Description — Temperature Range — Package

B.

Prefix	Device	Suffix
TMS	4030	JL

Package — Temperature Range

TOSHIBA

Description
TA Bipolar Linear
TC CMOS
TD Bipolar Digital
TM MOS

Package
P Plastic
M Metal
A Improved Type

Prefix	Device	Suffix
TA	7173	AP

WESTERN DIGITAL

Package
A 40 Lead DIP, Ceramic
B 40 Lead DIP, Plastic
C 24 Lead DIP, Ceramic
D 24 Lead DIP, Plastic
E 28 Lead DIP, Ceramic
F 28 Lead DIP, Plastic
G 22 Lead DIP, Ceramic
H 22 Lead DIP, Ceramic

Prefix	Device	Suffix
TR1602	A	01

Package — Special Parameter

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APPLICATION NOTE DIRECTORY

The Application Note Directory is a comprehensive guide to the many IC application notes available. It lists the devices covered, describes each note, and tells who publishes each one.

how to use the application note directory

The application notes in this directory can be located by function or device number.

1. To find out what is published by function, locate the closest topics in the index below, turn to the pages indicated, and scan through the listings.

2. To find all the application notes covering a given device, look up the device in the Part Number Index at the front of this book. The ¶ sign leads to application notes.

3. To find out what application notes are available from a particular manufacturer, look up the manufacturer in the Product Index. The table gives you the titles and the page locations for each manufacturer's application notes in this directory.

The application note descriptions are organized under the headings: Digital, Linear, Memory and Microprocessor. Beneath those headings are functional and applications categories arranged alphabetically. Within each category the notes are arranged in alphabetical sequence by manufacturer. The mixing of functions and applications is necessary, since application notes do not lend themselves to classification entirely by function or entirely by application. When an application note fits under several categories, it is listed in one and cross referenced by the others. This may mean that you have to spend five minutes checking a number of categories to be sure you've found everything you want, but finding suitable information can save you considerable design time.

If an application note covers specific devices or it shows in some detail how certain devices are used, these device numbers are listed in parentheses just below the title. If any of these device numbers are in bold face type, data on them is presented in The Master Selection Guide Data Sections.

The application note descriptions are as short as possible. They are designed to save you time in reading while giving an overall sense of the contents. The length of each note is indicated in parentheses on the last line; if the note is bound into a book, the last line will show that it is part of a handbook, databook, catalog, etc.

Once you have determined which application notes you need, contact the manufacturer's sales office or write to the manufacturer. Be sure to give both the title and the application note number. Addresses and phone numbers are listed in the Manufacturers and Distributors Directory.

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DIGITAL

Arithmetic

1 **"A Successive Approximation Register"**
(AM2502, AM2503, AM2504, AM25L02, AM25L03, AM25L04)
Operation, logic, coding of these 8 and 12 bit TTL devices. Describes applications in systems performing recursive arithmetic operations; as ring counters; serial-to-parallel converters.
Advanced Micro Devices Application Note (11 pg.)

2 **"The Am 2506—A Latching ALU"**
(AM2506)
Combines four-bit arithmetic logic unit and four-bit latch. Describes application in high-speed multiple word adder, multiple master-slave registers, 16-word arithmetic register, multiplication at 16 MHz rate.
Advanced Micro Devices Application Note (4 pg.)

3 **"The Am25S05, Am2505 and AM25L05 Schottky, Standard and Low Power TTL 2's Complement Digital Multipliers"**
(AM2505, AM25L05, AM25S05)
Discusses multiplication, two's complement notation, Booth's algorithm, iterative arrays, time-sequenced multipliers, integer and fractional multiplication, round-off, truncation and one's complement multiplication. Application to digital filters, square rooting and division.
Advanced Micro Devices Application Note (24 pg.)

4 **"Multiplying Made Easy for Digital Assemblies"**
(AM2505)
Discusses multiplication algorithms and use of the device.
Advanced Micro Devices (6pg.)

5 **"Overflow Detector in Binary Adders"**
(AM9309)
Discusses the detection of overflow errors using an IC multiplexer.
Advanced Micro Devices (2pg.)

6 **"A 2's Complement Digital Multiplier: The AM2505"**
(AM2505)
Discusses high speed multiplication and use of this device to perform 2's complement multiplication.
Advanced Micro Devices (11pg.)

7 **"Am25S10 Four-Bit Shifter"**
(AM25S10)
Provides functional description and discusses logic equivalents. Applications: up-shift, down and around end shifts, scaling and fixed multiplication.
Advanced Micro Devices Application Note (10 pg.)

8 **"Two's Complement Multiplication"**
See Digital Signal Processing Handbook under Digital-LSI General (AMD)

9 **"MNOS Digital Differential Analyzer"**
(CRC1502, CRC1503, CRC1504, CRC9503, CRC9504)
Describes theory of operation of a DDA integrator for the real time solution of differential equations. Covers use of 3 LSI devices including mapping, scaling, initializing, and coding to simulate a given set of algebraic or differential equations.
Collins Application Notes (7 pg.)

Arithmetic (cont)

10 **"Applications of the TTL/MSI 93S43 4-Bit by 2-Bit Two's Complement Multiplier"**
(93S43)
How to implement a combinatorial multiplication array of any size for two's complement numbers. How to multiply in other number representations. Speed/hardware tradeoffs, normalization of floating point numbers after multiplying, rounding or truncation of double length products.
Fairchild Application, Note 329 (15 pg.)

11 **"High Speed Binary Multiplication using the MC10181"**
See listing under High Speed Logic (Motorola)

12 **"MECL 10,000 Arithmetic Elements MC10179, MC10180, MC10181"**
See listing under High Speed Logic (Motorola)

13 **"NBCD Sign and Magnitude Adder/Subtracter"**
(MC14560, MC14561)
Describes CMOS parallel adder-subtracters for both signed and unsigned natural binary coded decimal (NBCD) numbers.
Motorola AN-738 (7 pg.)

14 **"Applications of the SM7200/DM8200 Digital Comparator"**
(DM7200, DM8200)
Describes use in word comparison, associative memory, bit exclusion, modulo N divider and servo system applications.
National AN-12 (6 pg.)

15 **"Arithmetic Arrays Using Standard COS/MOS Building Blocks"**
(CD4001, CD4008, CD4011, CD4013, CD4019)
Describes design of a 32-bit full adder/arithmetic logic system. Discusses four-bit full adder, quad AND-OR select gate, dual D-type flip-flop, input NAND gates, input NOR gates, and arithmetic register.
RCA ICAN-6600 (6 pg.)

16 **"COS/MOS Rate Multipliers-Versatile Circuits for synthesizing Digital Functions"**
(CD4089, CD4527)
Describes operation of a rate multiplier, and the effects of cascading. Covers addition, subtraction, multiplication, division, square and higher order roots, frequency ratios and integration. Also discusses symmetric operations.
RCA ICAN-6739 (12 pg.)

17 **"Converting To and From Binary Using the SN74184 and SN74185A"**
(SN74184, SN74185A, SN74283, SN74284, SN74285)
Compares conventional shift and add technique to conversion from binary to BCD using the 74185A. Tells how to interconnect these converter packages for 6-bit through 20-bit binary inputs and 4, 5 or 6 decade BCD inputs. Describes conversion of fractions using the 74283, 74284 and 74285.
Texas Instruments Application Report CA-171 (19 pg.)

18 **"Fast Multipliers Using TTL Read Only Memories"**
See listing under (Memory) ROMs. (Texas Instruments)

19 **"SN7497 Binary Rate Multiplier"**
(SN5497, SN7497)
Covers principles and internal operation of the binary rate multiplier (BRM); shows add, subtract, multiply, divide and square root operations with a minimum of control logic. Discusses the use of the BRM to solve differential equations and to generate functions.
Texas Instruments Application Report CA-160 (13 pg.)

CMOS

20 **"CMOS: Some Application Guidelines"**
Presents General Guidelines when using CMOS.
Harris Application Note 209 (7 pg.)

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CMOS (cont)

1 **"Minimizing Gate Oxide Failures Due to Handling"**
Describes oxide failure mechanisms, evaluates input protection techniques, and recommends handling procedures to avoid failure.
Harris Application Report 208 (3 pg.)

2 **"Using Junction Isolated CMOS"**
Covers problems and application rules related to forward biasing CMOS inputs and outputs.
Harris Application Note 210 (4 pg.)

3 **"Getting the Most Out of C-MOS Devices for Analog Switching Jobs"**
Describes latch-proof junction isolation, floating-body junction isolation, and dielectric isolation as solutions to CMOS problems when applied to analog design.
Harris Semiconductor AN-321 (7pg.)

4 **"CMOS Analog Multiplexers and Switches; Applications, Considerations"**
Covers selection criteria, parameter definitions, handling and design precautions, typical applications, and other topics concerning CMOS analog multiplexers and switches.
Harris Semiconductor AN-520 (9pg.)

5 **"Avoiding CMOS Noise-Sensitivity Proglems"**
Describes noise sensitivity proglems peculiar to MOS technologies and solution to these problems.
Harris Semiconductor AN-211 (6pgs.)

6 **"MasterMOS, a custom CMOS System"**
(MasterMOS)
Describes the contruction of these devices which are customized by changing the metalization pattern.
International Microcircuits (6 pg.)

7 **"MasterMOS Design Manual"**
(MasterMOS)
Detailed instructions and drawings for customizing these arrays.
International Microcircuits $35.00 (70 pg.)

8 **"A New CMOS Analog Gate Technology"**
See listing under (Linear) Switches. (Intersil)

9 **"NBCD Sign and Magnitude Adder/Subtracter"**
See listing under Arithmetic (Motorola)

10 **"A 3½ Digit DVM Using an Integrated Circuit Dual Ramp System"**
See listing under Linear-Instrumentation (Motorola)

11 **"Noise Immunity Comparison of CMOS Versus Popular Bipolar Logic Families"**
Compares the noise immunities of TTL, DTL, HTL, and CMOS logic families. Discusses common noise sources, precautions against noise, noise specification, and standard noise tests.
Motorola AN-707 (8 pg.)

12 **"Introduction To CMOS Integrated Circuits With Three-State Outputs"**
(MC14500 Series)
Describes a wide variety of CMOS ICs incorporating transmission gates with standard logic. Gives design rules. Covers applications in analog switching and multiplexing, digital multiplexing, and data bussing.
Motorola AN-715 (19 pg.)

13 **"Scanning Logic for RF Scanner-Receivers Using CMOS Integrated Circuits"**
Describes rf scanner-receiver control functions using standard CMOS devices. Covers crystal switching and priority channel monitoring with mention of phase-locked loop designs.
Motorola AN-753 (7 pg.)

CMOS (cont)

14 **"CMOS, the Ideal Logic Family"**
(MM54C/74C Series)
Describes characteristics of CMOS circuits. Discusses system considerations, such as unused inputs, data bussing, paralleling circuits for extra drive, and interface to other logic families.
National AN-77 (8 pg.)

15 **"CMOS Linear Applications"**
((MM74C00, MM74C02, MM74C04)
Describes use of CMOS devices biased to operate at the midpoint of the transfer characteristics.
National AN-88 (3 pg.)

16 **"CMOS Oscillators"**
Describes square wave oscillators that can be built with CMOS logic elements.
National AN-118 (4 pg.)

17 **"CMOS Schmitt Trigger—A Uniquely Versatile Design Component"**
(MM54C14, MM54C914, MM74C14, MM74C914)
Describes CMOS Schmitt trigger ICs with emphasis on the advantages over TTL versions, including high input impedance, wide threshold range, high noise immunity and low power consumption.
National AN-140 (6 pg.)

18 **"Using the CMOS Dual Monostable Multivibrator"**
(MM54C221, MM74C221)
Gives MM54C/MM74C221 circuit characteristics and operating suggestions. Shows use in a retriggerable one-shot, frequency magnitude comparator, Linear VCO and an analog multiplier-divider.
National AN-138 (6 pg.)

19 **"MM54C/74C Voltage Translation/Buffering"**
See listing under Interface (National)

20 **"54C/74C Family Characteristics"**
(MM54C/74C Series)
Discusses output, noise and temperature characteristics, power consumption, and propagation delay for the 54C/74C logic family.
National AN-90 (6 pg.)

21 **"Gate-Oxide Protection Circuit in RCA COS/MOS Digital Integrated Circuits"**
(CD4000 Series)
Gives description and schematics for the protection circuits.
RCA ICAN-6218 (2 pg.)

22 **"Interfacing COS/MOS with OTher Logic Families"**
(CD4000A Series)
Describes conditions governing interface of CMOS 4000A series with other logic families.
RCA SSD-203 ICAN-6602 (12 pg.)

23 **"Battery-Powered Digital-Display Clock/Timer and Metering Applications Utilizing the RCA CD4026A and CD4033A Decade Counters-7 Segment Output Types"**
(CD4009, CD4010, CD4026, CD4033)
Describes the CD4026A/33A ICs and their use with 7-segment display units. Discusses interface packages and methods to help the designer optimize his system. Includes a discussion of battery-operated systems for digital clocks and watches.
RCA ICAN-6733 (16 pg.)

24 **"Radiation Resistance of the COS/MOS CD4000A Series"**
(CD4000A Series)
Provides a graph plotting permanent radiation resistance of CD4000A series. Discusses design considerations for increasing resistance.
RCA ICAN-6224 (2 pg.)

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CMOS (cont)

1 **"Astable and Monostable Oscillators Using RCA COS/MOS Digital Integrated Circuits"**

Describes techniques to compensate for normal threshold variation of MOS devices in the design of stable multivibrator circuits for operation at frequencies up to 1MHz. Describes applications, including VCOs, voltage controlled pulse-width circuits, frequency multipliers, and modulators/demodulators (envelope detectors).

RCA Application Note ICAN-6466 (12 pg.)

2 **"COS/MOS MSI Counter and Register Design and Applications"**

((CD4006, CD4014, CD4015, CD4017, CD4018, CD4020, CD4021, CD4022, CD4024)

Includes logic and schematic diagrams for these counters and shift registers. Outlines circuit designs, discusses device-design tradeoffs and summarizes performance criteria.

RCA ICAN-6166 (16 pg.)

3 **"CMOS/MOS Interfacing Simplified"**

See listing under Interface (RCA)

4 **"COS/MOS Rate Multipliers-Versatile Circuits for Synthesizing Digital Functions"**

See listing under Arithmetic (RCA)

5 **"Noise Immunity of COS/MOS Integrated-Circuit Logic Gates"**

(CD4000A, CD4001A)

Evaluates noise immunity of the CD4000A/01A gates with respect to external noise, crosstalk, transmission-line reflections, power-line noise, and ground-line noise. Includes schematics and logic diagrams.

RCA ICAN-6176 (8 pg.)

6 **"Micropower Crystal-Controlled Oscillator Design Using RCA COS/MOS Inverters"**

(CD4007)

Describes in depth the design of low power crystal controlled oscillators and the exact frequency of oscillation.

RCA ICAN-6539 (8 pg.)

7 **"A Typical Data-Gathering & Processing System Using CD4000A-Series COS/MOS Parts"**

(CD4000 Series)

Describes data-gathering and processing system using CMOS circuits. Includes discussion of input signal conditioning and transmission, the digital processor unit, receiver, memory, arithmetic unit, display unit, output buffer, output transmitter, receiver, and control unit.

RCA ICAN-6210 (11 pg.)

8 **"Power-Supply Considerations for COS/MOS Devices"**

(CD4000 Series)

Includes discussion of quiescent device dissipation, switching characteristics, ac dissipation and ac performance characteristics, calculating system power, power supply regulation and filtering requirements.

RCA ICAN-6576 (6 pg.)

9 **"Using the CD4047A In COS/MOS Timing Applications"**

(CD4047)

Compares this monostable-astable multivibrator with simpler types of oscillator circuits and discusses applications, including a noise discriminator, low-pass and band-pass filters, a frequency discriminator, and a pulse generator.

RCA ICAN-6230 (13 pg.)

10 **"Handling and Operating Considerations for MOS Integrated Circuits"**

Discusses handling of unmounted chips and subassembly boards, working with automatic handling equipment, storing of p-c boards, operating voltage, connections to unused inputs, interfacing with other logic families, noise immunity, and device characteristics of CMOS ICs.

RCA ICAN-6000 (6 pg.)

CMOS (cont)

11 **"Guide to better Handling and Operation of CMOS Integrated Circuits"**

Recommends specific handling and operating practices to minimize the probability of damage in the manufacturing and field environments.

RCA ICAN-6525 (5 pg.)

12 **"Design of Fixed and Programmable Counters Using the RCA 4018A COS/MOS Presettable Divide-by-"N" Counter"**

See listing under Counters. (RCA)

13 **"The RCA COS/MOS Phase Locked-Loop—A Versatile Building Block for Micro-Power Digital and Analog Applications"**

See listing under (Linear) Phase Locked Loops. (RCA)

14 **"Application of CD4016A Quad Bilateral Switch"**

See "Transmission and Multiplexing of Analog or Digital Signals Using the CD4016A Quad Bilateral Switch" Under Data Transmission. (RCA)

15 **"A COS/MOS PCM Telemetry and Remote Data Acquisition Design"**

(CD4000 Series)

Describes data transmission formats and the following data acquisition sections: analog and digital multiplexers, A/D converters, transmission formatters and system programmers.

RCA ICAN-6289 (12 pg.)

16 **"Power Supplies for COS/MOS"**

(CD4000 Series)

Discusses the factors involved in the selection of CMOS supply voltages including the system operating frequency, noise immunity and power dissipation. Examples of simple power supply circuits are also given.

RCA ICAN-6304 (5 pg.)

17 **"Applications of the RCA-CD4093B COS/MOS Schmitt Trigger"**

(CD4093B)

Describes characteristics of the CD 4093 quad 2-input Schmitt trigger. Covers applications in waveshaping (sinewave to squarewave, edge delay, edge detection), power-on reset, astable multivibrators and use as a Schmitt trigger for noise immunity.

RCA ICAN-6346 (6 pg.)

18 **"Using the CD4520B to Design Dividers with Symmetrical Outputs"**

(CD4520B)

Describes how to use this CMOS counter to divide an input frequency by N where N is any integer from 2 to 256 and obtain outputs with approximately 50% duty cycles.

RCA ICAN-6362 (10 pg.)

19 **"COS/MOS Integrated Circuits Manual"**

(CD4000 series)

Discusses fabrication, logic system design, and applications of RCA COS/MOS circuits.

RCA CMS-271 $2.50 (224 pg.)

20 **"CMOS Expandable Gates"**

(SCL4402A, SCL4412A)

Compares the transfer characteristics of ordinary CMOS gates to those gates using double buffered output. Includes performance characteristics and discusses expansion of SCL4412A and SCL4402A to 12-input NOR, 16-input OR, and other combinations.

Solid State Scientific AN-102 (3 pg.)

21 **"Using the SCL4528 Dual Monostable Multivibrator"**

(SCL4528)

Describes operating modes and timing, equations for pulse width calculations.

Solid State Scientific AN-111 (6 pg.)

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CMOS (cont)

1 **"CMOS Wave Shaping and Level Detection"**

Describes methods to obtain modified transfer characteristics of double buffered NAND gates, by connecting inputs together, connecting extra inputs to V_{cc}, etc. Shows how to obtain variable amounts of hysteresis, and describes systems of level detection using trigger circuits.

Solid State Scientific AN-109 (5 pg.)

2 **"Using Complementary MOS Circuits"**

(SCL4013A, SCL4046A, SCL4018A, SCL4026A, SCL4029A, SCL4404A)

Reviews CMOS operation, cost, and reliability. Discusses application of the SCL4018A in a three decade rate multiplier; the SCL4029A in counting devices; the SCL4404A and SCL4031A in A/D converters; and SCL4016A in analog switching.

Solid State Scientific AN-101 (6 pg.)

3 **"Applications of CMOS Integrated Circuits In Communications Equipment"**

(SCL4000 Series)

Uses of SCL4000 Series circuits as frequency synthesizers, digital frequency displays, frequency scanners, and squelch circuits.

Solid State Scientific AN-108 (4 pg.)

4 **"A Simplified Approach to Testing CMOS Inverters and Gates"**

Bench tests using a iower supply and a V-O-M are described. They include continuity, input leakage, quiescent device current, output voltage, noise immunity, output drive current' and threshold voltage.

Solid State Scientific AN-107 (4 pg.)

5 **"Improved CMOS Gate Design"**

(SCL4000 Series)

Description of the output buffering o the SCL4000 Series

Solid State Scientific AN-105 (3 pg.)

6 **"Interfacing with CMOS"**

(SCL4000 Series)

Describes electrical characteristics of CMOS inputs and outputs. Discusses interfacing CMOS with CMOS, PMOS, NMOS, DTL/TTL, HTL, and CL.

Solid State Scientific An-104(5 pg.)

7 **"CMOS Integrated Circuits in Automotive Applications"**

General discussion, also includes discussion of high current circuits, constant current or constant impedance circuit, digital time delay circuit, digital low-pass filter.

Solid State Scientific AN-103 (5 pg.)

Consumer

8 **"A Navigation Receiver That Uses A Digital Frequency Synthesizer"**

(μA719)

Gives schematics for a navigation receiver. Discusses the digital frequency synthesizer, varactor tuned RF amplifier, AGC amplifier, mixer, IF amplifier, and detector portions.

Fairchild Application Note 178 (6 pg.)

9 **"Industrial Clock/Timer Featuring Back-up Power Supply Operation"**

Describes the design and operation of a clock timer with digital readout suitable for industrial control applications. CMOS circuits are used for reduced power.

Motorola AN-718A

10 **"Calculator Learns to Keep Time"**

(MM5736)

Describes stopwatch and keyboard controlled interval timing functions using the MM5736 calculator chip.

National AN-119 (8 pg.)

Consumer (cont)

11 **"Handheld Calculator Battery Systems"**

Describes the tradeoffs in battery performance for 6.5-9.5v calculators driven by 2, 3 and 4 cell as well as 9v, batteries.

National AN-149 (pg.)

12 **"High Voltage Shift Registers Move Displays"**

See listing under (Memory) Shift Registers (National)

13 **"Timekeeping Advances Through COS/MOS Technology"**

Discusses basic oscillator design considerations, practical oscillator circuits, and some typical timing-circuit applications, including wristwatches, wall clocks, and auto clocks.

RCA ICAN-6086 (12 pg.)

14 **"CMOS Integrated Circuits in Automotive Applications"**

See listing under CMOS. (Solid State Scientific)

15 **"Automotive Electronics: Choosing the Right Technology"**

Defines operational considerations and compares CMOS, PMOS, and bipolar.

Sprague TP 74-5 (10 pg.)

Converters

16 **"Binary D/A Converters Can Provide BCD-Coded Conversion"**

(MC1408, MC1508)

Describes the MC1508 D/A converter used as a 2 or 2½ digit BCD converter. Describes application in a 2½ digit digital voltmeter.

Motorola AN-713 (4 pg.)

Counters

17 **"Single IC Forms 2-to-9-Bit Ring Counter"**

(AM2503)

Describes use of device to make a ring counter.

Advanced Micro Devices (2 pg.)

18 **"Using the MK5009P MOS Counter Time-Base Circuit"**

(MK5009)

Describes the use of the MK5009 along with complete circuits for a digital frequency meter, pulse generator and digitally-programmable one-shot. Discusses operation of the units oscillator circuit.

Mostek AN-104 (4 pg.)

19 **"Applications Using the MK 50395 Six Decade Counter Display Totalizer"**

(MK50395, MK 50396, MK50397)

Discusses use of the counter in batch control position measurement, greater-than less-than detection, automatic stop, frequency counter, darkroom timer, digital tuning, and N-Pulser applications.

Mostek (16 pg.)

20 **"Application Information Using Mostek's Six-Decade Counter/Display Totalizer"**

(MK50395)

Covers circuit operation and input/output requirements. Describes use in a batch control system, a position measurement system and greater than-less than detection.

Mostek (8 pg.)

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Counters (cont)

1 **"Programmable Counters Using the MC10136 and MC10137 MECL Universal Counters"**
(MC10136, MC10137)
Circuit operation and use in programmable counters with no external gating. Also use in high-frequency counters operating up to 110 MHz.
Motorola AN-584 (4 pg.)

2 **"Battery-Powered 5-MHz Frequency Counter"**
Describes a battery operated 5 MHz counter built with CMOS for low power operation. Discusses methods to minimize power consumption.
Motorola AN-717 (9 pg.)

3 **"Five Digit Accumulator/Elapsed Time Indicator"**
(MC14534)
Describes in detail the circuit for a CMOS 5 digit elapsed time indicator and a 99,999 count accumulator with a 1-999 prescaler.
Motorola AN-743 (5 pg.)

4 **"The Logical Design of Shift Counters"**
Presents two techniques to aid in designing shift-register counters. Gives results for "sequence tree" and "count multiplication" techniques for cycle lengths of 30 or less. Shows solutions for both "D" flip-flops and J-K flip-flops as the input elements of the shift register.
Motorola AN-576 (8 pg.)

5 **"An MSI 500 MHz Frequency Counter Using MECL and MTTL"**
See listing under High Speed Logic. (Motorola)

6 **"Calculator Chip Makes A Counter"**
(MM5736, MM5739)
Discusses use of the MM5736 calculator chip as a counter operating up to 120 Hz.
National AN-112 (6 pg.)

7 **"Design of Fixed and Programmable Counters Using the RCA 4018A COS/MOS Presettable Divide-by-"N" Counter"**
(CD4018)
Describes the use of this device in single-decade and multi-decade fixed and programmable divide-by-"N" counters. System considerations, such as switch simplifications, components minimization, and speed are also discussed.
RCA ICAN-6498 (6 pg.)

8 **"Using the SN74160 Family of Synchronous Counters"**
(SN74160, SN74161, SN74162, SN74163)
Describes carry circuit operation, cascading and programming.
Texas Instruments Application Report CA-174 (7 pg.)

9 **"ECL High Speed Counters"**
Discusses design considerations when constructing high speed counters using the TI ECL 2500 Series.
Texas Instruments Application Report CA-147 (8 pg.)

Data Transmission

10 **"A Typical Data-Gathering and Processing System using CD4000A-Series COS/MOS Parts"**
See listing under CMOS (RCA)

11 **"Line Drivers and Receivers"**
(AM2614, AM2615, 9614, 9615, 9620, 9621, DM7831, DM8831)
Discusses single ended, differential, unbalanced differential digital communications systems and line matching methods. Describes the above circuits and their use in systems.
Advanced Micro Devices Application Note (12 pg.)

Data Transmission (cont)

12 **"Using the Data Concentrator in Data Communications"**
(AY1016)
Describes counter, decoding matrix, and multiplexer switch sections of the AY-5-1016 data concentrator. Describes commutator-decommutator and polling system applications plus use as a digitally programmable gain amplifier, and as a clock generator.
General Instrument Microelectronics (11 pg.)

13 **"The AY-5-1011 Terminal Transmitter for Key-To-Tape Data Accumulation System and Other Applications"**
(AY5-1011)
Describes features of this parallel-to-serial converter and discusses its use in key-to-tape systems.
General Instrument Microelectronics (6 pg.)

14 **The UAR/T in Data Communications**
(AY5-1013)
Describes this full deplex receiver/transmitter and discusses its application in computer, terminal and slow speed device interfacing. Also covers use in polling.
General Instrument Microelectronics (4 pg.)

15 **"High Speed Digital Communications"**
(HD245, HD246, HD545, HD546)
Describes the use of the HD-245 family in a current mode digital communication system (up to 2 Mbs over 1,000-ft-long line.)
Harris Application Note 205 (4 pg.)

16 **"Receiver/Transmitter Noise Immunity"**
(HD245, HD246, HD545, HD546)
Discusses HD-245 transmitter/receiver system noise: External magnetic and capacitive effects, crosstalk, and ground line noise. Includes a comparison with voltage mode and differential voltage switching type systems.
Harris Application Note 207 (4 pg.)

17 **"Using the 8251 Universal Synchronous/Asynchronous Receiver/Transmitter"**
(8251)
Describes this USART, covering its use as a component and as a communication link in 8080 systems. Includes flowcharts and program listings.
Intel Application Note AP-17 $1.00 (32 pg.)

18 **"Error Detection and Correction Using Exclusive-OR Gates and Parity Trees'**
(MC1030, MC4008, MC4010, MC10107, MCM10146, MC10160)
Discusses the use of Exclusive-Or gates and the parity trees available in the RTL, TTL, DTL, and ECL families for simple parity and single-error Hamming parity detection/correction circuits.
Motorola AN-496A (9 pg.)

19 **"Bussing with MECL 10,000 Integrated Circuits"**
(MC10111, MC10123)
Describes use of MECL 10,000 circuits in high speed data transmission systems with emphasis on transmission line construction and termination.
Motorola AN-726 (6 pg.)

20 **"Device Operation and System Implementation of the Asynchronous Communications Interface Adapter (MC6850)"**
(MC6850)
Provides information on ACIA transmitter and receiver operation, initialization, status register bits, use in a microcomputer based communications system, software requirements, and transmission subroutines.
Motorola AN-754 (11 pg.)

21 **"Low Speed Modem Fundamentals"**
(MC6860)
Describes interface circuitry and performance of the MC6860 low speed modem. Evaluation of the system performance in the presence of Gaussian noise is given, as well as a brief description of data couplers.
Motorola AN-731 (15 pg.)

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Data Transmission (cont)

1 **"Low-Speed Modem System Design Using the MC6860"**
(MC6860)
Describes the MC6860 modem. Provides filter design tables and equations to develop a complete 100 series compatible system.
Motorola AN-747 (13 pg.)

2 **"Operational Aspects of Motorola's Data Terminal Transmitter and Receiver"**
(MC2257, MC2259, MC2260)
Describes in detail the input and output signals for the synchronous/asynchronous operation of these parallel to serial transmitters and the serial to parallel receiver.
Motorola AN-724 (24 pg.)

3 **"Transmission Line Characteristics"**
(DM7400, DS7820, DS7830, DS75452, DS8820, DS8830)
Describes the characteristics of digital signals in transmission lines and the characteristics of the line that effect transmission quality. Also compares the performance of unbalanced and balanced circuits in digital systems.
National Interface Handbook, AN-108 (6 pg.)

4 **"Integrated Circuits for Digital Data Transmission"**
(DS7820, DS7830, DS8820, DS8830)
Describes the operation and use of the DS7830 line driver and DS7820 line receiver for transmission systems using twisted-pair lines. Includes a mathematical design analysis of this line receiver.
National Interface Handbook, AN-22 (16 pg.)

5 **"Data Bus and Differential Line Drivers and Receivers"**
(DS7820, DS7830, DS7831, DS7832, DS7833, DS7834, DS7835, DS7836, DS7837, DS7838, DS7839, DS8820, DS8830, DS8831, DS8832, DS8833, DS8834, DS8835, DS8836, DS8837, DS8838, DS8839, DS1488, DS1489)
Includes schematics and describes the operation of these line drivers, receivers and transceivers.
National AN-83 (12 pg.)

6 **"Operational Aspects of Nitron's Data Terminal Transmitter and Receiver"**
(NC2257, SC2259, NC2260)
Discusses basic operation of the NC2257/2259/2260 IC's, and application in various types of communications systems.
Nitron Communications Note 1 (24 pg.)

7 **"Using High Speed Memory in Pulse Code Modulated Systems for Switching Applications"**
Discusses digital message switching and implementation with a conventional digital crossbar switch as well as with a switch using high speed memory and data multiplexing.
Nortec Applications Note. No. 29 (4 pg.)

8 **"Transmission and Multiplexing of Analog or Digital Signals Utilizing the CD4016A Quad Bilateral Switch"**
(CD4016A)
Describes features and operation of this switch. Discusses applications, including switching, gating digital or analog signals, multiplexing and demultiplexing, D/A conversion, sample and hold, and squelch-control.
RCA ICAN-6601 (12 pg.)

9 **"A COS/MOS PCM Telemetry and Remote Data Acquisition Design"**
See listing under CMOS (RCA)

10 **"Data Transmission with SN55107 Series"**
(SN55107, SN55108, SN55109, SN55110, SN75107, SN75108, SN75109, SN75110)
Demonstrates the use of these line drivers and receivers in solving two multiplexing problems: a party line addressing system; and data/clock signals in a bipolar line. Receiver and driver characteristics are provided.
Texas Instruments Application Report CA-146 (8 pg.)

Data Transmission (cont)

11 **"Line Drivers and Receivers"**
(SN55107, SN55108, SN55109, SN55110, SN75107, SN75108, SN75109, SN75110)
Circuit operation, circuit characteristics, and system applications are covered. Typical performance using different types and lengths of line are provided, as well as notes on selecting a transmission system. Also mentions use as a comparator, line repeator, window detector and temperature controller.
Texas Instruments Application Report CA-130 (33 pg.)

12 **"Asynchronous Receiver/Transmitter"**
(TR1602)
General description of asynchronous transmission and operation of TR1602, which is capable of full or half duplex operation. Describes application in distributed computer networks.
Western Digital Application Report 1 (12 pg.)

Decoders

See also Interface.

13 **"Applications of the 9538 ECL/MSI High Speed Decoder"**
See listing under High Speed Logic (Fairchild)
See also Interface.

14 **"Driving 7-Segment Gas Discharge Display Tubes With National Semiconductor Circuits"**
(DS7880, DS8880, DS8884A, DS8885, DS8887, DM8889)
Describes decoder/driver circuits and applications, including interfacing 7-segment fully decoded MOS chips to digit displays and interfacing with numeric display tubes.
National AN-84 (4 pg.)

15 **"Features and Applications of RCA-CD2500E-Series MSI BCD-to-7-Segment Decoder-Drivers"**
(CD2500, CD2501, CD2502, CD2503)
Discusses logic levels, operating characteristics, display-lamp turn-on characteristics, static drive applications, time multiplex systems, and a fail-safe circuit.
RCA ICAN-6294 (11 pg.)

Encoders

16 **"Using the AY-5-9100 in Telephone Equipment"**
(AY5-9100)
Describes use of this four phase dynamic logic circuit in mains powered dialers, line powered telephones, card readers, and in standard multifrequency tone dialer keyboards.
General Instrument Microelectronics (10 pg.)

17 **"Designing with the HD-0165 Keyboard Encoder"**
(HD0165)
The organization and truth table for this encoder are presented. The use of two circuits for encoding up to 256 keys, battery operation, examples of a teletypewriter keyboard and universal keyboard encoders are described.
Harris Application Note 204 (8 pg.)

18 **"90 Keyboard Encoder Arrays"**
(MCS1009, MCS1020, MCS1021)
Describes the operation of these keyboard arrays and illustrates their application in keyboard encoding systems.
MOS Technology Application Note AN1 (22 pg.)

19 **"64 Key Keyboard Encoder Arrays"**
(MCS1007, MCS1010)
Describes operation and optional features of these keyboard encoders.
MOS Technology Application Note AN2 (21 pg.)

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Encoders (cont)

1 **"Using the MM5704 Keyboard Interface In Keyboard Systems"**
(MM5704)
Discusses features, operation, and programming of this device. Discusses use with the MM5702 timing and control chip of the Microprogrammable Arithmetic Processing System, and in a standard ASCII encode system.
National AN-52 (11 pg.)

2 **"MOS Encoder Plus PROM Yield Quick Turnaround Systems"**
(MM5740)
Describes use of a binary coded keyboard encoder with a PROM to build prototype or small volume keyboard systems.
National AN-139 (4 pg.)

3 **"MOS Keyboard Encoding"**
(MM5740)
Describes circuit and operation of the MM5740 keyboard interface circuit, including input-output interface, the repeat function key, data strobe control and output enable. Discusses applications, including a polling system for localized keyboards and complete ASR-33 keyboard.
National MOS Handbook AN-80 (11 pg.)

Filters

4 **"Basic Digital Filter Theory"**
See Digital Signal Processing Handbook under Digital/LSI General (AMD)

General

5 **"Don't Be Confused by IC Switching Time Specifications"**
Uses a TTL, J-K flip-flop to explain switching time specifications.
Advanced Micro Devices (4 pg.)

6 **"MOS 100-Bit Word Generator"**
Describes how to build a 100-bit word generator using MOS ICs.
National MOS Brief 1 (2 pg.)

7 **"MOS Clock Savers"**
Design and use of MOS Clock-Drive Networks. Offers tips for saving power and lowering component costs.
National MOS Brief 5 (2 pg.)

8 **"Solid-State Devices Manual"**
Provides tutorial information on discrete devices and IC's with emphasis on consumer, hobbyist and experimenter applications.
RCA SC-16 $5.00 (750 pg.)

High Speed Logic

9 **"Applications of the 9538 ECL/MSI High Speed Decoder"**
(9538)
Includes applications of this 1 of 8 decoder in demultiplexing, code decoding, memory decoding, function generation.
Fairchild Application Note 308 (10 pg.)

10 **"F10,000 Series ECL"**
(ECL Series)
Operation and circuit parameters are described for the Fairchild ECL series.
Fairchild Application Note 330 (6 pg.)

High-Speed Logic (cont)

11 **"Measure Frequency and Propagation Delay with High-Speed MECL Circuits"**
(MECL)
Describes ECL frequency counter useful to 160 MHz and a propagation delay measuring circuit capable of 100-picosecond resolution.
Motorola AN-586 (2 pg.)

12 **"A High Speed FIFO Memory Using the MECL MC10143 Register File"**
(MCM10143)
Describes the required features of a high speed FIFO design. Different approaches are compared and a design is shown using the MC10143 Multiport Register File.
Motorola AN-730 (6 pg.)

13 **"Testing MECL 10,000 Integrated Logic Circuits"**
(MECL)
Describes AC and DC tests in a 50 ohm transmission-line environment for measuring logic levels or noise margins, circuit current, input currents, propagation delays, edge speeds, and flip-flop toggle rates.
Motorola AN-579 (6 pg.)

14 **"An MSI 500 MHz Frequency Counter Using MECL and MTTL"**
(MECL)
Describes design of 8-digit LED readout counter using MECL III, 10,000 and TTL. Discusses two prescalers using MECL, two input amplifier designs, and a time-base controller for the counter's multiphase clock.
Motorola AN-581 (9 pg.)

15 **"Bussing with MECL 10,000 Integrated Circuits"**
See listing under Data Transmission (Motorola)

16 **"Interconnection Techniques For Motorola's MECL 10,000 Series Emitter Coupled Logic"**
(MECL)
Describes some of the characteristics of high digital signal lines and gives wiring rules for MECL 10,000 circuits. Discusses p-c board interconnects, board-to-board interconnects, and wirewrapping techniques.
Motorola AN-556 (22 pg.)

17 **"Using Shift Registers As Pulse Delay Networks"**
(MC10135)
Discusses a high-speed delay shift register using the MC10135 flip flop.
Motorola AN-565 (3 pg.)

18 **"High Speed Binary Multiplication Using the MC10181"**
(MC10181)
Describes a 4-bit by 4-bit multiplier using this arithmetic unit. Shows expansion to 8-by-8-bit or 17-by-17-bit systems.
Motorola AN-566 (3 pg.)

19 **"MECL Positive and Negative Logic"**
(MECL)
Describes equivalences between positive and negative ECL logic and provides guides for converting between them.
Motorola AN-567 (2 pg.)

20 **"Interfacing With MECL 10,000 Integrated Circuits"**
(MC1650, MC1692, MC10115, MC10116 MC10124, MC10125, MC10128, MC10129, MC10216)
Discusses circuits to interface ECL with TTL, TTL and IBM busses, MOS, low level signals, and LEDs.
Motorola AN-720 (9 pg.)

21 **"The MC1600 Series MECLIII Gates"**
(MC1660, MC1661, MC1662, MC1663, MC1664, MC1665)
Gives typical operating characteristics and explains the operation of various gates in the MECL III family. Describes recommended layout, breadboarding, and testing procedures.
Motorola AN-504 (14 pg.)

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High-Speed Logic (cont)

1 **"IC Crystal Controlled Oscillators"**
(MC1023, MC1662, MC10101, MC10116)
Describes use of MC1023 OR/NOR gate as an amplifier and oscillator. Discusses square wave oscillator circuits with crystal control capable of output frequencies up to 150 MHz. Examples use MC10116/10101, and MC1662.
Motorola AN-417A (4 pg.)

2 **"High Speed Monostable Multivibrators Designed With MECL Integrated Circuits"**
(MC1023, MC1026)
Discusses two configurations using the MC1023 clock driver and a delay element that offer performance in excess of 70 MHz and pulse widths of 4 nanoseconds. Covers methods of obtaining the delay.
Motorola AN-418 (5 pg.)

3 **"MECL 10,000 Arithmetic Elements MC10179, MC10180, MC10181"**
(MC10179, MC10180, MC10181)
Describes 10180 dual adder/subtractor, 10181 4-bit arithmetic logic unit/function generator, and 10179 lookahead carry block. Discusses their operation in parallel adders, in both ripple and lookahead systems.
Motorola AN-709 (11 pg.)

4 **"Simulate MECL System Interconnections With A Computer Program"**
Develops a basic computer program that allows the user to simulate the performance of signal lines and to analyze termination techniques. Applies to ECL and other high speed digital systems.
Motorola AN-700 (10 pg.)

5 **"Understanding MECL 10,000 DC and AC Data Sheet Specifications"**
(MECL)
Discusses basic MECL 10,000 gate structure, transfer curve and dc levels. Covers specifications data sheet, including power supply drain current, hgih and low output voltages, propagation delay, rise and fall times, and toggle frequency.
Motorola AN-701 (7 pg.)

6 **"AC Noise Immunity of MECL 10,000 Integrated Circuits"**
(MECL)
Discusses AC noise immunity. Describes test circuits for measuring this immunity and the results to be expected for MECL 10,000 circuits.
Motorola AN-592 (6 pg.)

High Speed TTL

7 **"The MC3000/MC3100 Series Transistor-Transistor Logic Flip-Flops"**
(MC3050, MC3051, MC3052, MC3060, MC3061, MC3062, MC3150, MC3151, MC3152, MC3160, MC3162)
Describes basic operation of the various flip-flops available in the MC3000/3100 (54H/79H) series and gives typical operating characteristics of each.
Motorola AN-493 (14 pg.)

8 **"Series 54S/74S Schottky TTL Applications"**
(SN54S Series, SN74S Series)
Analyzes Schottky clamping techniques and circuits, reviews circuit performance, including discussion of transfer characteristics, switching times, and a-c noise. Discusses power supply considerations, line driving and receiving, noise sources and their abatement. Normalized loading/driving capability information and the pinouts of ICs are discussed.
Texas Instruments Application Report CA-176 (45 pg.)

HNIL/HTL

9 **"Converting Relay Control Systems To Digital I/C's"**
(MC660 Series)
Defines and discusses basic Boolean algebra and logic functions and presents method of converting relay diagrams to logic diagrams. Gives examples of conversion method using High Threshold Logic circuits and presents a system design to accomplish this.
Motorola AN-524 (14 pg.)

HNIL/HTL (cont)

10 **"Using Motorola High Threshold Logic"**
(MC660 Series)
Describes MC660 series ICs and provides many of the characteristics of these units. Application examples include logic translation, line driving, and trigger circuits.
Motorola AN-467 (11 pg.)

11 **"Operation and Application of MHTL I/C Flip-Flops"**
(MC663, MC664)
Describes operation and characteristics of the J-K MC663P and the master-slave R-S MC664P flip-flops. Discusses applications as ripple and decade shift counters.
Motorola AN-414 (8 pg.)

12 **"Noise Immunity With Motorola High Threshold Logic"**
(MC660 Series)
Compares noise immunity characteristics between High Threshold Logic (HTL) and standard saturated logic devices. Discusses noise injection and noise reduction techniques.
Motorola AN-298 (5 pg.)

13 **"Combining HNIL and CMOS—An Optimum Design Technique"**
See listing under Interface (Teledyne Semiconductor)

14 **"High Noise Immunity Logic—Powerful, Versatile, and Growing"**
(300 Series)
Generally describes the HiNIL family use and features. Covers interface to other families, noise immunity, operating considerations and input protection.
Teledyne Semiconductor Digital Application Note 5 (5 pg.)

15 **"The HiNIL 347-A Dual Retriggerable One Shot with High Noise Immunity"**
(347)
Description and application details for this device are provided along with diagrams showing its use in pulse generators, coincidence detectors, frequency dividers, voltage to frequency and frequency to voltage converters, a pulse absence detector and an ac line presence detector.
Teledyne Semiconductor Digital Application Note 6 (6 pg.)

16 **"HiNIL 375 Universal Shift Register"**
(375)
Operation and applications of this synchronous 4-bit device as a 4 and 8-bit shift-left, shift-right register, 7 and 8-bit parallel-to-serial and serial-to-parallel converters and various counters.
Teledyne Semiconductor HiNIL Application Note 4 (10 pg.)

17 **"High Noise Immunity Logic"**
(300 Series)
Discussion includes noise immunity, loading rules, fanout, passive pull-up loading, collector or-ing, second level gating, driver pull-up, system interfaces.
Teledyne Semiconductor Digital Catalog (7 pg.)

18 **"Design Techniques with HiNIL 367 Quad Schmitt Trigger;;**
(367)
General discussion of Schmitt Trigger and the differences of the 367, which ignores open inputs and offers 3.5v noise immunity. Applications include line receivers, pulse stretchers, ac detectors, free-running and voltage-controlled oscillators.
Teledyne Semiconductor HiNIL Application, Note 2, (4 pg.)

19 **"Designing Programmable Controllers with HiNIL"**
(380)
Applications of the HiNIL 380 BCD to decade decoder including the generation of odd sequences of output pulses, the controlling of more than one load, and the switching on and off of loads.
Teledyne Semiconductor Digital Microcircuits Application, Note 3 (4 pg.)

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I^2L

1 **"Custom IC Design Using I^2L (XR-IIL-CHIP) Technology"**

Compares I^2L to other technologies. Describes design procedure for linear and digital circuits using master chips.
Exar (5 pg.)

Interface

See also Decoders.

2 **"9616/9617 EIA Interface Driver and Receiver"**

(9616, 9617)
Giver performance characteristics for these devices and describes their use in data communications equipment. Describes EIA standard RS232-C.
Fairchild Application Note 320 (6 pg.)

3 **"The Interface Handbook, Line Drivers and Receivers"**

(9612, 9613, 9614, 9615, 9616, 9617, 9627, 9634, 9635, 9636, 9637, 9638, 9640, 8T13, 8T14, 8T23, 8T24, 55107, 55108, 55109, 55110, 55121, 55122, 75107, 75108, 75109, 75110, 75112, 75121, 75122, 75123, 75124, 75154, 75207, 75208)

This comprehensive book covers the basics of transmission line theory along with methods for determining signal quality. Major chapters are titled: Data Transmission Lines and their Characteristics; Reflections, Computations and Waveforms; Long Transmission Lines and Data Signal Quality; and Forms of Operation (single/differential, direction of flow, analysis of common interfaces, etc.)
Fairchild Interface Handbook (118 pg.)

4 **"ASCII Bus Interface Logic Uses IM5200 FPLA"**

(IM5200)
Explains ASCII interface bus and how IM5200 provides discrete logic and address storage required by it.
Intersil Application Bulletin MB002 (6 pg.)

5 **"Interfacing with MECL 10,000 Integrated Circuits"**

See listing under High Speed Logic (Motorola)

6 **"Interfact Techniques Between Industrial Logic and Power Devices"**

(MC660 Series, MC14000 Series)
Presents worst case design approaches to illustrate methods of interfacing McMOS and MHTL logic to various ac and dc power load levels. Gives examples using transistors and thyristors as load drivers. Covers direct coupled and level translation interfacing as well as opto-electronic coupling for high isolation.
Motorola AN-712A (18 pg.)

7 **"Semiconductors For Plated-Wire Memories"**

(MC4006, MC4007, MC4038, MC4040, MC4043, MC1514, MC1546)
Discusses operation and electrical characteristics of plated wire memories. Covers applications of drivers, sense amplifiers, and decoders as interface circuits. Also discusses memory organization and memory-related semiconductor applications.
Motorola AN-533 (15 pg.)

8 **"Interface Techniques Between Industrial Logic and Power Devices"**

Presents worst case design approaches to illustrate methods of interfacing McMOS and MHTL logic to various ac and dc power load levels.
Motorola Applications Report AN-712A (19 pg.)

9 **"Interface Considerations for Numeric Display Systems"**

(MC14511, MC14543)
Gives basic information on LCD, LED, gas discharge, fluorescent and incandescent displays. Discusses interfacing 7 segment displays to logic with emphasis on multiplexed systems.
Motorola AN-741 (25 pg.)

Interface (cont)

10 **"MM54C/MM74C Voltage Translation/Buffering"**

(MM54C901, MM54C902, MM54C903, MM54C904, MM74C901, MM74C902, MM74C903, MM74C904)
Interfacing PMOS to CMOS, CMOS to CMOS with different voltage levels, and CMOS to two standard TTL loads, are illustrated using 74C901 series devices.
National MB-14 (2 pg.)

11 **"Interfacing With MECL 10,000 Integrated Circuite"**

See listing under High Speed Logic (Motorola)

12 **"Driving 7-Segment LED Displays with National Semiconductor Circuits"**

(DM5446A, DM5447A, DM5448A, DM7446A, DM7447A, DS75491, DS75492, DS7856, DS7858, DS8856, DS8857, DS8858, DS8861, DS8863, DS8864, DS8865, DS8866)
Discusses configurations and construction of 7-segment LEDs and drive modes. Describes BCD to 7-segment decoder drivers, BCD to 7-segment LED drivers, MOS to LED segment drivers, four and five segment drivers, as well as digit drivers. Describes calculator and digital clock applications.
National Interface Handbook, AN-99 (12 pg.)

13 **"Using the MM5704 Keyboard Interface in Keyboard Systems"**

See listing under Encoders. (National)

14 **"TTL/MOS/DTL Interfaces"**

Techniques for coupling the above devices and characteristics of the interfaces.
National MOS Brief 7 (2 pg.)

15 **"COS/MOS Interfacing Simplified"**

(CD4000 Series)
Covers interfacing 4000A and B series with TTL, DTL, ECL, NMOS, PMOS, industriand power control circuits, op amps and displays.
RCA ICAN-6315 (7 pg.)

16 **"Applications of the RCA-CD4093B COS/MOS Schmitt Trigger"**

See listing under CMOS (RCA)

17 **"Interfacing COS/MOS with Other Logic Families"**

See listing under CMOS (RCA)

18 **"Interfacing with CMOS"**

See listing under CMOS. (Solid State Scientific)

19 **"Completely Monolithic IC Series for Gas Discharge Display Interface"**

(UDN-6144, UDN-6164, UDN-6184, UDN-7183, UDN-7184, UDN-7186)
Describes operation of high voltage IC's to drive the digits and segments of 200v (Panaplex) gas discharge displays.
Sprague Electric Microcircuit Application Report MAR75-1 (8 pg.)

20 **"Using Bipolar Logic to Improve Performance in CMOS and Microprocessor Systems"**

Suggests the use of HiNIL for improving noise performance, input protection, and output drive, and of LP Schottky for improved speed/power.
Teledyne Semiconductor Digital Application Note 7 (4 pg.)

21 **"Combining HNIL and CMOS—An Optimum Design Technique"**

(300 Series)
Discusses noise immunity, HNIL/74C interface, Schmitt trigger input and high current output.
Teledyne Semiconductor Digital Catalog (3 pg.)

22 **"TTL to MOS and MOS to TTL Interface Circuits"**

(SN7400, SN75107, SN75207, SN75270, SN75370, SN75450, SN75451, TMS1103, TMS4062)
Describes MOS/TTL interface circuits using bipolar transistors,JFETS, MOSFETS, and ICs.
Texas Instruments Application Report CA-170 (11 pg.)

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Interface (cont)

1 **"Monolithic Interfacing in Computers"**
(SN7520 Series, SN75107, SN75109, SN75308, SN75324)
Discusses linear integrated circuits for computer interface applications including line circuits, memory drivers, and sense amplifiers.
Texas Instruments Application Report CA-122 (12 pg.)

2 **"Peripheral Interface Circuits with the SN75450"**
(SN75450)
A variety of logic level translation, lamp driving and power control circuits are given using SN75450 series peripheral drivers.
Texas Instruments Application Report CA-150 (6 pg.)

LSI, General

3 **"Digital Signal Processing Handbook"**
(AM2505, AM25S05, AM25LS14, AM25LS15)
Covers digital filter theory and design with an airborne MTI radar as an example. Discusses Booth's algorithm in 2's complement multiplication and describes how to implement such multipliers/dividers with IC's.
AMD (84pg.)

4 **"Advances in LSI Using Silicon Gate Technology"**
Discusses the silicon gate process and silicon gate devices in general. Compares silicon gate with other MOS technologies with respect to device characteristics, the effects of these characteristics, chip interconnection, chip area, and device fabrication.
Fairchild Application Note 307 (6 pg.)

5 **"Design of Custom LSI Circuitry for Modern Digital Systems"**
Discusses design of LSI devices. Covers size considerations, numbers of input/output connections, number of output drivers, use of repetitive patterns, use of computer aided design techniques, speed versus size and power, and interfacing.
General Instrument Microelectronics (7 pg.)

Multiplexers

6 **"TTL MSI Multiplexers and Demultiplexers"**
(DM7210, SM7842, DM8210, DM8842)
Describes features of DM7210 multiplexer and DM7842 demultiplexer and discusses their use in a synchronous digital data transmission system, a keyboard entry decoder, and as minterm generators.
National AN-37 (8pg.)

PLAs

7 **"How To Design With Programmable Logic Arrays"**
(DM8575, DM8576)
Discusses operation of PLAs and use as code converters, decode elements in digital processors and sequential controllers.
National AN-89 (8 pg.)

8 **"MOS Programmable Logic Arrays"**
TMS2000 Series, TMS2200 Series)
Describes TMS2000 and TMS2200 Series programmable logic arrays. Describes their internal logic and operations. Provides ordering instructions.
Texas Instruments Application Report CA-158 (13 pg.)

Pulse Handling

9 **"Nanosecond Pulse Handling Techniques in I/C Interconnections"**
Discusses problems of pulse transmission and measurement for TEM mode on coax, stripline, and above-ground wire systems.
Motorola AN-270 (6 pg.)

Trigger Circuits

10 **"Advantages of the AM26123 Compared with the AM54/74123"**
(AM26123, SN54123, SN74123)
Discusses changes in the pulse width circuits and the addition of an output latch.
Advanced Micro Devices Application Brief (4 pg.)

11 **"1.3 volt IC Flasher, Oscillator, Trigger, or Alarm"**
See listing under Linear-Timers (National)

12 **"Series ULN-3300M Schmitt Trigger Integrated Circuits-Typical Applications and Operation"**
(ULN-3303, ULN-3304, ULN-3305, ULN-3306)
Describes device and use in multivibrators, switches, timers, and more.
Sprague AN-27450.19

13 **"Design Techniques with HiNIL 367 Quad Schmitt Trigger"**
See listing under HNIL/HTL (Teledyne Semiconductor)

14 **"The HiNIL 347—A Dual Retriggerable One Shot with High Noise Immunity"**
See listing under HNIL/HTL (Teledyne Semiconductor)

15 **"TTL One-Shot: SN74121"**
(SN74121)
Brief description of the SN74121 monostable multivibrator or "one-shot". Applications: stable gated clock pulse generator and a digital frequency-to-voltage converter.
Texas Instruments Application Report CA-128 (4 pg.)

TTL, General

17 **"The Control Engineers Guide to IC Applications"**
See listing under (Linear) Industrial Control (Motorola)

18 **"The TTL Applications Handbook"**
(9300, 9301, 9302, 9304, 9305, 9307, 9308, 9309, 9310, 9311, 9312, 9313, 9314, 9315, 9316, 9317, 9318, 9321, 9322, 9324, 9328, 9334, 9338, 9340, 9341, 9342, 93S43, 9344, 9345, 9348, 9350, 9352, 9353, 9354, 9356, 9357, 9358, 9359, 9360, 9366, 9368, 9369, 9370, 93H72, 9375, 9377, 9383, 9390, 9391, 9392, 9393, 9394, 9395, 9396, 9600, 9601, 9602, 9603, 74121, 74122, 7442, 7443, 7444, 7446, 7447, 7448, 7449, 7475, 7477, 7483, 7490, 7491, 9492, 7493, 7494, 7495, 7496, 74123, 74141, 74150, 74153, 74164, 74165, 74181, 74182, 74192, 74193, 7488A, 93141, 93150, 93153, 93164, 93165, 93410, 93415)
Gives diagrams and short descriptions of many IC applications grouped under the following categories: multiplexers, decoders, displays, encoders, operators (adders/subtractors, multipliers/dividers, comparator systems, error detection/correction, code conversion), latches, memories, registers, counters, small scale integration, low power TTL, Schottky TTL, monostable multivibrators and transmission line interface elements. The introduction discusses the advantages of MSI and general design rules. The final chapter covers electrical properties, physical system considerations, and interfacing with other forms of logic. Each application is brief, and various uses are shown for the ICs.
Fairchild TTL Applications Handbook (355 pg.)

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TTL, General (cont)

1 **"Medium Scale Integration In the Numerical Control Field"**
(MC4016, MC4018, MC4024, MC4044, MC4324, MC4344)
Discusses operation of MC4016 decade programmable cascadeable counter, MC4324/4024 dual voltage controlled multivibrator, and MC4344/4044 frequency phase detector. Describes applications of these devices in audio frequency comparator, frequency synthesizer, and motor speed control circuits.
Motorola AN-541 (10 pg.)

2 **"TTL Integrated Circuits—Applications of MSI Devices"**
Covers counters, modulo-N dividers, decoders, switches, adders, comparators, parity generators, shift registers and bus-ORable flip-flop. Describes many applications, including up/down counters, a stepping waveform generator, shift registers, frequency synthesizers, digital data demultiplexer, analog commutator, minterm generator, ripple carry parallel adder and tape position locator.
National AN-36 (23 pg.)

3 **"Tri-State Logic in High-Speed Memories of Microprogrammed Computers"**
(DM8551)
Discusses tri-state logic in general and its use in scratchpad memories. Covers storage of microinstructions and program constants in high-speed ROMs.
National AN-47 (5 pg.)

4 **"Tri-State Logic Applied In a Computer System Can Reduce System Cost and Provide Added Performance"**
(DM8556)
Analyzes Tri-State characteristics using the DM8556 counter/register as an example. Shows how performance of PDP-8 can be improved using TSL.
National AN-73 (7 pg.)

5 **"Characteristics and Applications of Tri-State IC's"**
(DM7093, DM7490, DM7214, DM7230, DM7551, DM7598, DS7831, DS8831)
Describes application of the general configuration of the Tri-State logic family and discusses application of the following: quad bus-buffer gates, dual 4:1 multiplexer, demultiplexer and bus-interchange switch, quad-D flip-flop, expandable 256-bit ROM, and quad driver.
National AN-45 (12 pg.)

6 **"Tri-State Logic in Modular Systems"**
(DS7831, DM8093, DM8094, DM8214, DM8230, DM8551, DM8552, DM8598, DS8831, DM8840, DM8842, DM8846)
Discusses output drive characteristics, logical control, safety factors in Tri-State Logic circuits. Describes applications, including complex switching functions, driving and transmitting, multiplexing, data storage, decoding, and data manipulation.
National AN-43 (16 pg.)

LINEAR

Active Filters

7 **"Active Filter Design Examples Using Universal Active Filters"**
(UAF11, UAF15, UAF21, UAF25)
Shows calculation of external component values for low pass and band reject filters.
Burr-Brown AN-61 (4 pg.)

8 **"High Q Notch Filter"**
(LM102, LM202, LM302)
Describes use of LM102 connected to a twin "T" network to form a high Q, 60Hz notch filter.
National Linear Applications LB-5 (2 pg.)

Amplifiers, Current

9 **"Application of the LH0002 Current Amplifier"**
(LH0002)
Circuit operation. Describes uses in a differential input-output op amp, booster amplifier, level shifter, pulse transformer driver, and transmission line driver.
National Linear Applications Handbook, AN-13 (4 pg.)

Amplifiers, Differential

10 **"AD520 Monolithic Instrumentation Amplifier"**
(AD520)
Describes performance of this instrumentation amplifier. Covers application as a bridge amplifier, ground loop eliminator, and floating measurement amp. Appendix compares instrumentation amplifier to several multiple op amp circuits.
Analog Devices (6 pg.)

11 **"Instrumentation Amplifiers-versatile differential input gain blocks"**
(3660, 3670)
Describes the features and general operation of instrumentation amplifiers. Depicts their use in bridge circuits, in reducing ground loop interference, and in driven guard input circuits.
Burr-Brown AN-75 (6 pg.)

12 **"A General Purpose IC Differential Output Operational Amplifier"**
(MC1420, MC1520)
Discusses application of the MC1520 as a wideband non-inverting operational amplifier, as well as inverting operational amplifier, a differential amplifier with either simple-ended input or differential input/output. Also discusses circuit operation, power connections, frequency compensation and feedback.
Motorola AN-407 (5 pg.)

13 **"Instrumentation Amplifier"**
(LM101A, LM102, LM107)
Describes a differential-input instrumentation amplifier using LM102 and LM107 and variable gain version that also uses LM101A.
National Linear Applications LB-1 (2 pg.)

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Amplifiers, Differential (cont)

1 **"Application of the RCA-CA3000 Integrated-Circuit DC Amplifier"**
(CA3000)
Describes circuit and application as modulated oscillator, crystal oscillator, low-frequency mixer, cascaded RC-coupled feedback amp, narrow-band tuned amp, and Schmitt trigger.
RCA ICAN-5030 (11 pg.)

Amplifiers, Operational

2 **"Specifying Selected Op Amps and Comparators"**
See listing under Comparators (National)

3 **"Radiation testing of Linear Microcircuits"**
See listing under (Linear) General (Fairchild)

4 **"AD513, AD516, IC FET Input Operational Amplifiers"**
(AD513, AD516)
Describes the circuit and operation. Applications include: comparator, precision clipper, current-to-voltage converter, and a timer.
Analog Devices Technical Bulletin (4 pg.)

5 **"Applying the AD504 Precision IC Operational Amplifier"**
(AD504)
Describes this amplifier and offers notes on its noise, thermal and dynamic performance, Applications: instrumentation amplifier, stable reference regulator, instrument input amplifier and high gain ac amplifier.
Analog Devices Technical Bulletin (7 pg.)

6 **"High Speed Op Amps—How Fast is Fast?"**
Comments on op-amp characteristics, including slew rate, settling time, stability and phase margin.
Analog Devices Reprint (6 pg.)

7 **"IC FET Input Operational Amplifiers"**
(AD503, AD506)
Describes these devices and their circuit characteristics. Applications: triangle and square wave generator, charge amplifier, track and hold amplifier, D.C. voltmeter, peak rectifier, bridge amplifier and current-to-voltage converters.
Analog Devices Technical Bulletin (6 pg.)

8 **"Combine Two Op Amps to Avoid the Speed Accuracy Compromise"**
(3521)
Discusses interconnecting low drift and wideband op amps to form a composite op amp.
Burr-Brown AN-64 (2 pg.)

9 **"Check Five Op Amp Specs in One Test"**
Describes a test circuit that generates signals providing measurements of open loop gain, offset voltage, input bias current, quiescent current, and output voltage swing.
Burr-Brown AN-65 (1 pg.)

10 **"Protect Op Amps from Overloads"**
Discusses protection from power-supply faults, keeping input voltages at safe levels, and limiting output currents.
Burr-Brown AN-60 (3 pg.)

11 **"A Non-Inverting Differentiator"**
Bootstrapping an RC differentiator yields a precision differentiator without the phase inversion of a conventional op amp circuit. Discusses technique and operations.
Burr-Brown AN-67 (1 pg.)

12 **"Using Op Amps in Low Noise Applications"**
Discusses shot noise and noise from source resistances.
Burr-Brown AN-68 (2 pg.)

Amplifiers, Operational (cont)

13 **"A Simplified Precision Rectifier with Variable Gain"**
Operational Amplifiers are used to build a rectifier circuit with variable gain.
Burr-Brown AN-78 (2 pg.)

14 **"Design of a Unique Precision Controlled Current Source"**
Diagrams a current source using an op amp and a complementary FET pair to form a current source with differential input and bipolar current output.
Burr-Brown AN-74 (2 pg.)

15 **"The μA739—A Low-Noise Dual Operational Amplifier"**
(μA739)
Describes the circuit and operating characteristics. Covers d-c circuit performance, low-frequency analysis, power consumption, noise, short-circuit protection, amplifier isolation, and compensation techniques.
Fairchild Application Note 195 (8 pg.)

16 **"Applications of the μA741 Operational Amplifier"**
(μA741)
Describes applications of this amplifier as a unity gain voltage follower, integrator, differentiator, voltage regulator reference amplifier, high voltage regulated power supply control element, clipping amplifier, and a comparator.
Fairchild Application Note 289/1 (4 pg.)

17 **"Applications of the μA777"**
(μA777)
Discusses use of this operational amplifier as a pulse amplifier, Wein Bridge oscillator, variable gain differential amplifier, power amplifier.
Fairchild Application Note 300 (3 pg.)

18 **"Operational Amplifiers as Inductors"**
(μA777)
Includes derivation of equivalent circuit and necessary component values to obtain inductances from millihenries to kilohenries, using the μA777 as an example. Describes application in voltage controlled sinewave oscillators and in bandpass and notch filters.
Fairchild Application Note 321 (5 pg.)

19 **"The μA776, An Operational Amplifier with Programmable Gain, Bandwidth, Slew-Rate, and Power Dissipation"**
(μA776)
Describes methods for setting the master bias current, discusses amplifier frequency response as a function of this current. Discusses applications, including a 600 nanowatt amplifier, a low-cost sample and hold circuit, a current controlled oscillator, multiplexing, and phase shifting.
Fairchild Application Note 218 (5 pg.)

20 **"Applications of the μA749 Dual Operational Amplifier"**
(μA749)
Describes applications as a dual level comparator, positive or negative peak detector, peak-to-peak detector, and as an offset null circuit.
Fairchild Application Note 268 (2 pg.)

21 **"The μA749 Dual Operational Amplifier"**
(μA749)
Discusses the circuit, input voltage range, latch-up, output voltage range, power dissipation, noise, separation, high frequency compensation, and output capability.
Fairchild Application Note 269 (8 pg.)

22 **"The μA715—A Versatile High Speed Operational Amplifier"**
(μA715)
Describes application as an image orthicon head amplifier, general purpose video amplifier, 40dB high input impedance amplifier, and high speed sample and hold circuit.
Fairchild Application Note 265 (4 pg.)

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Amplifiers, Operational (cont)

1 **"A Low Drift, Low Noise Monolithic Operational Amplifier For Low Level Signal Processing"**
(μA725)
Describes operation of μA725, which offers low offset drifts, low input currents, low noise performance, and massive open loop gain. Shows how to minimize offset voltage drift with temperature in IC operational amplifiers and how to improve the common-mode rejection.
Fairchild Application Note 277 (10 pg.)

2 **"An Improved Sample and Hold Circuit Using the μA740"**
(μA740)
Basic discussion of acquisition and hold times. Description of circuit using this op amp as the buffer amplifier.
Fairchild Application Note 297 (3 pg.)

3 **"Frequency Compensation Techniques for an Integrated Operational Amplifier"**
(μA702A)
Presents design techniques for frequency compensation of μA702A which are applicable to other IC operational amplifiers.
Fairchild Application Bulletin 117/2 (8 pg.)

4 **"The HA-2530/2535 Wideband High Slew Inverting Amplifier"**
(HA-2530, HA-2535)
Briefly discusses internal circuit. Shows how closed-loop frequency response can be predicted. Describes application as a fast settling coaxial driver, a 10 MHz coaxial line driver, a wide range signal separator, a high frequency triangular wave generator, and a current-to-voltage converter.
Harris Application Note 516 (11 pg.)

5 **"Applications of a Monolithic Sample-and-Hold/Gated Operational Amplifier"**
(HA-2420, HA-2425)
Describes HA-2420/2425 circuit. Applications include various track-and-hold/sample-and-hold configurations, an A/D converter, a demultiplexer, an integrated-hold-reset amplifier, a gated operational amplifier, and a peak detector with reset.
Harris Application Note 517 (8 pg.)

6 **"The HA-2900 Monolithic Chopper Stabilized Amplifier"**
(HA-2900)
Discusses offset voltage and current drift and chopper stabilization, then describes the circuit. Applications include a high impedance differential instrumentation amplifier, use as an integrator, and several wide bandwidth configurations.
Harris Application Note 518 (8 pg.)

7 **"The HA-2400 PRAM Four Channel Operational Amplifier"**
(HA-2400, HA-2405)
This is a programmable input stage, operational amplifier. This note describes its applications including an analog multiplexer with buffered input and output, an inverting or non inverting amplifier with programmable gain, a sine wave oscillator with programmable frequency, and a track and hold/sample and hold circuit.
Harris Application Note 514 (8 pg.)

8 **"Operational Amplifier Stability: Input Capacitance Considerations"**
(HA-2600, HA-2605)
Discusses overcoming stray capacitance in op amps, such as the HA-2600.
Harris Application Note 515 (2 pg.)

"A Simple Function Generator Using Operational Amplifiers"
(HA-2600, HA-2510)
9 Describes square and triangular waveform generator using HA-2600 and HA-2510 op amps.
Harris Application Note 507 (2 pg.)

10 **"Test Procedures for Operational Amplifiers"**
Circuit for measuring offset voltage, bias current, offset current, open loop voltage gain, common mode and power supply rejection ratios, output voltage/current, power dissipation, and making continuity checks.
Harris Application Note 508 (2 pg.)

Amplifiers, Operational (cont)

11 **"A Simple Comparator Using the HA-2620"**
(HA-2620)
Describes op amp comparator circuit capable of driving approximately ten logic gates.
Harris Application Note 509 (1 pg.)

12 **"A Simple Square-Triangle Waveform Generator"**
(HA-2510, HA-2600, HA-2620)
Circuit for waveform generator using three op amps.
Harris Application Note 510 (2 pg.)

13 **"HA-909 Operational Amplifier"**
(HA-909, HA-911)
Discusses applications as a unity gain breadboard op amp, servo preamplifier, high-Q bandpass filter, Wien bridge oscillator, and phase-delay filters.
Harris Application Note 501 (2 pg.)

14 **"HA-909 Operational Amplifiers Performance Tailoring"**
(HA-909, HA-911)
Discusses how to optimize HA-909's offset, power dissipation, bandwidth, large signal bandwidth, slew rate, transient response, and stability with reactive loads.
Harris Application Note 502 (3 pg.)

15 **"Automatic Phase Margin Testing"**
(HA-2600)
How to test op amps using an HA-2600 comparator, the 8405A vector voltmeter and a sweep generator.
Harris Application Note 504 (2 pg.)

16 **"A High Impedance Hysteresis Circuit"**
(HA-2520, HA-2620)
Describes HA-2520/HA-2620 used as a hysteresis amplifier and covers output voltage limiting.
Harris Application Note 505 (2 pg.)

17 **"Equivalent Input Noise Measurements on High Gain Monolithic Operational Amplifiers"**
(HA-709, HA-909, HA-2520, HA-2600)
Broadband noise versus bandwidth measurements for HA-709, 909, 2520, and 2600 op amps.
Harris Application Note 506 (2 pg.)

18 **"Operational Amplifier Noise Prediction"**
Provides a noise model, a procedure for computing output noise, and spot noise curves for many Harris amplifiers.
Harris Semiconductor AN-519 (10 pg.)

19 **"The 8007—A High Performance FET-Input Operational Amplifier"**
(8007)
Circuit description, applications as log and antilog amplifiers, photocell amplifier, peak detector, sample and hold circuits, high impedance buffer, and Wien Bridge oscillator.
Intersil Application Bulletin A005 (6 pg.)

20 **"The 8043—A Low Cost Dual FET-Input Operational Amplifier"**
(8043)
Summary of circuit characteristics. Applications as automatic offset suppression circuit, staircase generator, sample and hold circuit, and instrumentation amplifier.
Intersil application Bulletin A008 (6 pg.)

21 **"The MC1556 Operational Amplifier and Its Applications"**
(MC1456, MC1556)
Gives characteristics and describes operation. Discusses application as a voltage follower, high impedance bridge amplifier, and a logarithmic amplifier.
Mototola AN-522 (8 pg.)

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Amplifiers, Operational (cont)

1 **"Single Power Supply Operation of IC Operational Amplifiers"**
(MC1430, MC1431, MC1433, MC1530, MC1531, MC1533, MC1709, MC1709C)
Describes a split zener biasing technique that permits the use of these operational amplifiers from a single power supply. Discusses general circuit as well as specific ac and dc device considerations to minimize operating and design problems.
Motorola AN-403 (3 pg.)

2 **"The MC1539 Operational Amplifier and Its Applications"**
(MC1439, MC1539)
Discusses dc and ac operation and the performance of this amplifier. Describes a high frequency feed-forward scheme and application as a comparator, voltage follower, differential amplifier, and a summing amplifier.
Mototola AN-439 (22 pg.)

3 **"A Simple Technique for Extending Op Amp Power Bandwidth"**
(MC1433, MC1533)
Describes a method of reducing loop gain and using only as much compensation as needed to increase the power bandwidth. Cites the MC1533G as an example.
Motorola AN-459 (3 pg.)

4 **"Using Transient Response To Determine Operational Amplifier Stability"**
(MC1439, MC1539)
Describes a technique for evaluating the stability of any feedback amplifier configuration by analyzing its response to a step-function input. Includes a theoretical analysis and an example using the MC1539 operational amplifier.
Motorola AN-460 (9 pg.)

5 **"The MC1535 Monolithic Dual Operational Amplifier"**
(MC1435, MC1535)
Gives complete ac and dc circuit analysis and discusses electrical characteristics. Discusses applications in a differential input-differential output circuit configuration, and as a signal envelop detector. Describes an input compensation scheme for fast slew rate.
Motorola A-411 (9 pg.)

6 **"Getting More Value Out Of An Integrated Operational Amplifier Data Sheet"**
(MC1439, MC1539)
Describes operational amplifier open loop characteristics and significance to overall circuit operation. Discusses loop gain stability and bandwidth, also reviews offset voltage and current and resultant drift effects for closed loop operation. Uses MC1439/1539 as examples.
Motorola AN-237A (9 pg.)

7 **"The MC1530, MC1531 Integrated Operational Amplifiers"**
(MC1430, MC1431, MC1530, MC1531)
Describes the function of each stage in the circuit, methods of frequency compensating and dc biasing. Discusses application as a summing circuit, integrator, dc comparator, and a transfer function simulator.
Motorola AN-204A (13 pg.)

8 **"Analysis and Design of the OP/Amp Current Source"**
Develops expressions for the transfer function and output impedances of voltage controlled op amp current source using both ideal and non-ideal models. Discusses effects of parameter and temperature variations on performance.
Motorola AN-587 (7 pg.)

9 **"An Applications Guide for Operational Amplifiers"**
(LH101, LH201, LM101, LM210, LM301)
Discusses applications of operational amplifiers, grouping them in five categories: simple amplifiers, operational circuits, transducer amplifiers, wave shapers and generators, and power supplies.
National Linear Applications AN-20 (12 pg.)

Amplifiers, Operational

10 **"A Simplified Test Set for Operational Amplifier Characterization"**
(LM101, LM201, LM301, LM709)
Gives a functional description of set that allows quantitative characterization of the dc operational amplifier parameters for the LM101 and LM709. Discusses the circuit, includes construction information, and gives a layout for the tester circuit boards.
National Linear Applications AN-24 (12 pg.)

11 **"IC Op Amp Beats FETs on Input Current"**
(LM108, LM208, LM308)
Describes LM108 operation and performance. Applications: sample and hold circuit, integrator, sine wave oscillator, capacitance multiplier, instrumentation amplifier, logarithmic converter, transducer amplifier, current source and voltage comparator. Discusses PC board construction.
National Linear Applications AN-29 (20 pg.)

12 **"Logarithmic Converters"**
(LM101A, LM102, LM108)
Describes log generators, anti-log generators, cube generators, and multiplier/dividers, using the LM101A and LM108 op amps.
National Linear Applications AN-30 (4 pg.)

13 **"Op Amp Circuit Collection"**
(LM101A, LM102, LM107, LM108)
Gives schematics only for some 90 circuits using one or more of the following operational amplifiers: LM101A. LM102, LM107, LM108. Includes basic, signal generation and signal processing circuits.
National Linear Applications AN-31 (20 pg.)

14 **"New Design Techniques for FET Op Amps"**
(LH0022, LH0022C, LH0042C, LH0052, LH0052C)
Gives parameters for LH0022, LH0042 and LH0052 operational amplifiers. Discusses rationale for FETs in these devices, describes the circuits. Describes application as voltage followers, integrators, sample/hold amplifiers, comparators, instrumentation and charge amplifiers.
National Linear Applications AN-63 (12 pg.)

15 **"Micropower Circuits Using the LM4250 Programmable Op Amp"**
(LM4250, LM4250C)
Describes LM4250 circuit and bias current setting procedure. Applications: 500 nano-watt amplifier, micro-power comparator meter amplifier, pulse generator, instrumentation amplifier and a 5V regulator for CMOS logic circuits.
National Linear Applications AN-71 (8 pg.)

16 **"The LM3900—A New Current-Differencing Quad of ±Input Amplifiers"**
(LM3900)
Describes Norton "current mirror" circuit. Emphasizes the amplifiers' application in circuits for single power supply systems. Discusses use in ac and dc amplifiers, voltage regulators, RC active filters, waveform generators, phase locked loops, and voltage controlled oscillators.
Also covers designing digital and switching circuits, and special applications, including tachometers, squating amplifiers, positive feedback oscillators, line operated audio amplifiers, and power circuits.
National Linear Applications AN-72 (39 pg.)

17 **"Applications For A High Speed FET Input Op Amp"**
(LH0062, LH0062C)
Describes circuit, performance, compensation techniques for LH0062. Discusses applications in high speed sample and hold circuit, high speed peak detector, programmable integrator, and wide band ac voltmeter. Covers heat sinking, guarding, and bootstrapping.
National Linear Applications AN-75 (4 pg.)

18 **"Feedforward Compensation Speeds Op Amp"**
(LM101A. LM201A, LM301A)
Compares standard frequency compensation with feedforward frequency compensation of LM101A. Charts open loop response for both compensation networks. Shows fast integrator circuit.
National Linear Applications LB-2 (2 pg.)

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Amplifiers, Operational (cont)

1 **"Fast Compensation Extends Power Bandwidth"**
(LM101A, LM201A, LM301A)
Describes frequency compensation technique that extends power bandwidth of LM101A for non-inverting gains of unity to ten and also reduces gain error at moderate frequencies.
National Linear Applications LB-4 (2 pg.)

2 **"Precision AC/DC Converters"**
(LM101A, LM201A, LM301A)
Describes the use of the LM101A in a circuit for eliminating diode threshold potential, use as a precision clamp, as a fast half wave rectifier, and precision AC to DC converter.
National Linear Applications LB-8 (2 pg.)

3 **"Universal Balancing Techniques"**
Describes offset voltage adjustment: for inverting amplifiers using less than 10 K source resistance or using any type of feedback element, for non-inverting amplifiers, for voltage followers, and for differential amplifiers.
National Linear Applications LB-9 (2 pg.)

4 **"Speed Up the LM108 With Feedforward Compensation"**
(LM108, LM208, LM308)
Describes simple feedforward netword for use with LM108 to achieve a factor of five improvement in speed.
National Linear Applications LB-14 (2 pg.)

5 **"Easily Tuned Sine Wave Oscillators"**
(LM101A, LM111, LM201A, LM211, LM301A, LM311)
Describes a circuit using the LM101A and LM111 that provides both a sine and square wave output for frequencies for below 20 Hz to above 20KHz. Also describes low distortion sine wave oscillator using two LM101As.
National Linear Applications LB-16 (2 pg.)

6 **"LM118 Op Amp Slews 70 V/μS"**
(LM118, LM218, LM318)
Describes this operational amplifier with 15 MHz bandwidth. Covers a compensation scheme to approximately double bandwidth and slew rate, and one for minimum settling time.
National Linear Applications LB-17 (2 pg.)

7 **Predicting Op Amp Slew Rate Limited Response"**
Discusses slew rate limiting and gives curves for sine wave and step voltage response.
National Linear Applications LB-19 (2 pg.)

8 **"Low Power Operational LH0001 Amplifier"**
(LH0001)
Operation of circuit offering 0.2 mv typical offset voltage at 25°C and quiescent supply currents in 100 μA range.
National Linear Applications Handbook, AN-10 (4 pg.)

9 **"Monolithic Operational Amplifiers—The Universal Linear Component"**
(LM101, LM102)
Applications of the LM101 and, in some cases, the LM102, include free-running multivibrator, level shifting amplifier, voltage comparator, servo preamplifier, and computing circuits. Frequency compensation techniques are discussed in detail.
National Linear Applications Handbook, AN-4 (10 pg.)

10 **"Drift Compensation Techniques for Integrated DC Amplifiers"**
Op amp bias current and offset voltage compensation are discussed. Current compensation techniques for high impedance levels and methods to achieve chopper-stabilized drift performance at low impedance levels are covered.
National Linear Applications Handbook, AN-3 (4 pg.)

11 **"True RMS Detector"**
Describes circuit using operational amplifiers that provide dc output equal to rms value of input with 2% accuracy for a 20 V_{p-p} input signal from 50Hz to 100kHz.
National Linear Brief-25 (2 pg.)

Amplifiers, Operational (cont)

12 **"Instrumentational Amplifiers"**
(LM114, LM118)
Discusses general purpose instrumentation amplifier, using LM114 matched transistors ahead of an LM118 op amp that is optimized for wide bandwidth.
National Linear Brief-21 (2 pg.)

13 **"Low Drift Amplifiers"**
(LM121, LM725, LM741, LM308)
Discusses problems causing circuit drift in amplifiers and recommends solutions. Includes discussion of thermal and electrical shielding, resistor choice, circuit layout, and offset balancing.
National Linear Brief-22 (2 pg.)

14 **"Versatile IC Preamp Challenges Choppers On Drift"**
See listing under Pre-amplifiers. (National)

15 **"Noise Specs Confusing?"**
Explanation of terms and factors contributing to noise; calculation of noise figure and signal to noise ratio. Gives points on selecting low noise amplifiers.
National AN-104 (8 pg.)

16 **"Use the LM158/LM358 Dual, Single Supply OP Amp"**
(LM158, LM258, LM358)
Proposes using this dual op amp with a single supply in place of the MC1458/MC1558 with a split supply.
National AN-116 (4 pg.)

17 **"Simple Precision Millivolt Reference Uses No Zeners"**
(OP-05)
Describes −3.5 mv to 3.5 mv reference built with instrumentation op amp and a potentiometer.
Precision Monolithics AN-10 (1 pg.)

18 **"The OP-07 Ultra-Low Offset Voltage Op Amp—A Bipolar Op Amp That Challenges Choppers, Eliminates Nulling"**
(OP-07)
Describes circuit design, compares performance to other devices. Covers application in a voltage reference, a high accuracy buffer, a D/A test system, a composite summing amplifier, an absolute value circuit, an alalog computer building block, and as a thermocouple amplifier.
Precision Monolithics AN-13 (12 pg.)

19 **"Minimization of Noise in Operational Amplifier Applications"**
(OP-07)
Describes internal and external sources of noise. Helps to locate noise sources by frequency. Gives examples of noise calculation using the OP-07 as an example.
Precision Monolithics AN-15 (11 pg.)

20 **"Applications of the RCA CA3048 Integrated Circuit Amplifier Array"**
(CA3048)
Discusses operating parameters for this 4-amplifier array and covers applications, including Hartley and Colpitts oscillators, an astable multivibrator, four-channel linear mixer, and a gain-controlled amplifier.
RCA ICAN-4072 (8 pg.)

21 **"Applications of the CA3080 and CA3080A High-Performance Operational Transconductance Amplifiers"**
(CA3080, CA3080A)
This device has additional control terminal for flexibility. Circuit operation is discussed. Applications covered: communications and industrial systems, modulators, multiplexers, sample and hold circuits, gain control circuits, and micropower comparators. Appendix discusses current mirrors.
RCA ICAN-6668 (16 pg.)

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Amplifiers, Operational (cont)

1 **"Application of the RCA CA3015 and CA3016 Integrated-Circuit Operational Amplifiers"**
(CA3015, CA3016)
Describes operating characteristics at ± 12 v. Applications covered are: 50-dB amplifier; twin-T bandpass amplifier; 20-dB, 10-MHz bandpass amplifier; and voltage follower.
RCA ICAN-5213 (6 pg.)

2 **"Application of RCA CA3033 and CA3033A High Performance Integrated-Circuit Operational Amplifiers"**
(CA3033, CA3033A)
Describes the basic circuit and operation. Covers application as a 250 mw, power amplifier and shows use in a DVM as a multivibrator, staircase generator, and comparator.
RCA ICAN-5641 (8 pg.)

3 **"Measurement of Burst (Popcorn) Noise in Linear Integrated Circuits"**
Discusses "pass-fail" criteria and describes a test set up for measuring burst noise. The setup includes a high gain amplifier-filter, a bipolar comparator, and a counter-latch-timer control circuit.
RCA ICAN 6732 (8 pg.)

4 **"Application of the RCA CA3008 and CA3010 Integrated-Circuit Operational Amplifiers"**
(CA3008, CA3010)
Describes operating characteristics of two op amps and their application in video amplifiers, frequency-shaping amplifiers, comparators, integrators, differentiators, scaling adders. Also covers the addition of a power output stage and/or input emitter followers.
RCA ICAN-5015 (15 pg.)

5 **"L144 Programmable Micro-Power Triple Op Amp"**
(L144)
Describes device function, elements of programming, effects of slew rate limiting. Applications discussed include instrumentation amplifier, tone detectors, triple-amplifier active filters, and a micropower double-ended limit detector.
Siliconix Application Note AN73-6 (6 pg.)

Amplifiers, Power

6 **"The MC1554 One-Watt Monolithic Integrated Circuit Power Amplifier"**
(MC1554)
Describes the circuit, including dc characteristics, frequency response, and distortion. Shows how to calculate package power dissipation using the curves on the data sheet. Describes application, as one watt non-inverting, inverting, pulse power, and three-watt differential output amplifiers.
Motorola AN-401 (7 pg.)

7 **"Audio Handbook"**
See listing under Consumer, Audio (National)

8 **"LM380 Power Audio Amplifier"**
See listing under Consumer, Audio. (National)

9 **"LM377, LM378, LM379 Dual Two, Four and Six Watt Power Amplifiers"**
(LM377, LM378, LM379)
Discusses operation, choice and use of these circuits in audio applications. Covers distortion and heat dissipation. Also covers use in a bridge configuration, plus use as a Wein bridge power oscillator, motor drive, power comparator, relay and lamp driver.
National AN-125 (11 pg.)

Amplifiers, Power (cont)

11 **"Application of the RCA CA3020 and CA3020A Integrated Circuit Multi-Purpose, Wide-Band Power Amplifiers"**
(CA3020, CA3020A)
Circuit description and operation. Both circuits operate from single supply voltage as low as +3 v, offer voltage gains over 60 dB with a 3 dB bandwidth of 8 MHz. Discussion of audio, broadband and video amplifier, video line driver, motor controller and servo amp applications.
RCA ICAN-5766 (8 pg.)

12 **"Operational Amplifier Parameter Definition and Measurement Guide"**
Defines parameters and means of measuring them.
Teledyne Philbrick AN-23 (8 pg.)

Amplifiers, RF

13 **"An Integrated Circuit AGC IF Amplifier"**
(μA757)
Describes circuit and performance of μA757, which is recommended for applications in military and industrial equipment, also speech compressor amplifiers.
Fairchild Semiconductor Application Note 204 (4 pg.)

14 **"A High Gain Integrated Circuit RF-IF Amplifier With Wide Range AGC"**
(MC1590G)
Describes operation and Y parameters of the MC1590G. Applications include mixers plus IF, video, single and two-stage RF amplifiers.
Motorola AN-513 (10 pg.)

15 **"A Two-Stage 1kW Solid-State Linear Amplifier"**
Discusses the design of 50W and 300W linear amplifiers for the 1.6 to 30 MHz frequency band.
Motorola AN-758 (16 pg.)

16 **"Linear Amplifiers for Mobil Operation"**
Discusses the design of a portable amplifier suitable for amateur radio applications.
Motorola AN-762 (8 pg.)

17 **"A Complete Monolithic AM/FM/SSB IF Strip"**
See listing under Consumer, AM/FM (National)

18 **"Applications of the LM173/LM273/LM373"**
(LM173, LM273, LM373)
Discusses FM, AM, and SSB operation of this multi-mode IF amplifier/detector.
National Linear Applications LB-13 (2 pg.)

19 **"Tuned Circuit Design Using Monolithic RF/IF Amplifiers"**
(LM171, LM703)
Discusses operating parameters for the LM171 and LM703 in emitter-coupled and cascode configurations. Brief description of 10.7 MHz emitter-coupled stage and 100 MHz cascode amplifier.
National Linear Applications Handbook, AN-6 (6 pg.)

20 **"Logarithmic IF Strips Using Monolithic Integrated Circuits"**
(SL521)
Describes operation of this log amplifier in successive detection type IF strips with center frequencies from 10 to 100 MHz. Covers broadband and narrow band circuits and describes in detail a 60 MHz wide-range logarithmic amplifier.
Plessey Semiconductor Technical Communication (3 pg.)

21 **"Logging IF Strip"**
(SL 1521)
Describes a logging IF strip using Plessey IC's.
Plessey Semiconductor (2 pg.)

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Amplifiers, RF (cont)

1 **"Application of the RCA-CA3002 Integrated-Circuit IF Amplifier"**
(CA3002)
Describes circuit, operating modes, characteristics, and application as an envelope detector, product detector, and a Schmitt trigger.
RCA ICAN-5036 (9 pg.)

2 **"Principal Features and Applications of the RCA-CA3040 Integrated-Circuit Wideband Amplifier"**
(CA3040)
Discusses bias modes, characteristics and ratings, stability, mounting, connections, and typical wideband amplifier circuits.
RCA ICAN-5977 (11 pg.)

3 **"Application of the RCA-CA3028A and CA3028B Integrated-Circuit RF Amplifiers in the HF and VHF Ranges"**
(CA3028A, CA3028B)
Describes circuits and operating modes. Covers use as an RF amp, autodyne converter, IF amp, and limiter.
RCA ICAN-5337 (10 pg.)

4 **"Application of the RCA CA3021, CA3022, and CA3023 Integrated-Circuit Wideband Amplifiers"**
(CA3021, CA3022, CA3023)
Describes circuit and operating characteristics. Covers video, 10 MHz IF, 455 KHz IF, 28 MHz two-stage limiter, and 500 kHz limiting amplifier applications.
RCA ICAN-5338 (12 pg.)

5 **"Application of the RCA CA3004, CA3005, and CA3006 Integrated-Circuit RF Amplifiers"**
(CA3004, CA3005, CA3006)
Discusses operating modes, Y parameters, noise performance, video amp capabilities, gain control, cross modulation and modulation distortion. Covers application as single-ended RF amplifier, tuned IF amplifier, mixer, suppressed-carrier modulator and product detector.
RCA ICAN-5022 (26 pg.)

Amplifiers, Sense

6 **"Semiconductors for Plated-Wire Memories"**
See listing under (Digital) Interface (Motorola)

7 **"The MC1541, A Gated Dual-Channel Sense Amplifier For Core Memories"**
(MC1441, MC1541)
Discusses circuit operation, design considerations, interface problems, and applications.
Motorola AN-474 (10 pg.)

8 **"An Integrated Sense Amplifier For Core Memories"**
(MC1440, MC1540)
Discusses core memories and design considerations for a sense amplifier. Establishes performance and environmental specs for amplifier design, analyzes design of MC1540, and discusses measured performance.
Motorola AN-245A (7 pg.)

Amplifiers, Video

9 **"Gated Video Amplifier Applications—The MC1545"**
(MC1445, MC1545)
Reviews basic operation and discusses applications, including several modulators, gated multivibrators, gated oscillators and FSK systems. Also discusses AGC, single supply operation, and temperature compensation of the active gate.
Motorola AN-491 (15 pg.)

Amplifiers, Video (cont)

10 **"Using the MC1545, A Monolithic Gated Video Amplifier"**
(MC1445, MC1545)
Describes ac and dc operation and discusses applications as a video switch, amplitude modulator, balanced modulator, pulse amplifier, frequency shift keyer and wideband differential amplifier.
Motorola AN-475 (7 pg.)

11 **"A Wide Band Monolithic Video Amplifier"**
(MC1552G, MC1553G)
Describes basic operation of the MC1552G and MC1553G, and the characteristics obtained as a function of the devices' operating modes. Applications: pulse amplifier, summing/scaling amplifier, oscillator, and tuned amplifier.
Motorola AN-404 (13 pg.)

12 **"Television Video IF Amplifier Using Integrated Circuits"**
See listing under Consumer, TV (Motorola)

13 **"Application of the RCA-CA3001 Integrated-Circuit Video Amplifier"**
(CA3001)
Describes circuit and operating characteristics. Covers cascaded stages and use as a Schmitt trigger.
RCA ICAN-5038 (9 pg.)

14 **"The SG1401 Video Amplifier"**
(SG1401)
Discussion of fixed and variable gain. The high frequency stability is discussed to aid in optimizing the various configurations for this device.
Silicon General Linear IC Product Guide (2 pg.)

Arrays

15 **"Using the SL362C Low Noise Transistor Pair"**
(SL362)
Provides general data on noise performance plus application in DC to 200 MHz amplifier.
Plessey Semiconductor Technical Communication (4 pg.)

16 **"Application of the RCA CA3018 Integrated Circuit Transistor Array"**
(CA3018)
Array of two isolated silicon epitaxial transistors plus two transistors with emitter-base common connections, suited for closely matched device requirements or interconnections with non-integrable components. Applications covered include IF-RF, video, agc, audio and dc amplifiers.
RCA ICAN-5296 (5 pg.)

17 **"Application of the RCA-CA3019 Integrated-Circuit Diode Array"**
(CA3019)
Describes circuit configuration, operating characteristics and applications, including balanced modulator, high-speed gates, balanced mixer, and a ring modulator.
RCA ICAN-5299 (6 pg.)

18 **"Designing With An IC Transistor Array Containing Matched Super-Beta Transistors"**
(CA3095)
Describes CA3095 IC array. Applications: low frequency amplifier, low noise video amplifier, long-delay monostable multivibrator, low-input-bias current comparator, analog timer for long delays, high input impedance dc-voltmeter circuit, and tape-head preamplifier.
RCA ICAN-6222 (9 pg.)

19 **"Monolithic Darlington Arrays Reduce Interface Cost and Complexity"**
(ULN-2001A, ULN-2002A, ULN-2003A)
Discusses packaging and heat dissipation of these 50v, 100-350 ma units. Covers parallel operation, input currents and control of up to 125 watts.
Sprague Electric Microcircuit Application Report MAR 75-2 (8 pg.)

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Arrays (cont)

1 **"Series ULN-2000A Darlington Transistor Arrays-Description and Application"**
(ULN-2001A, ULN-2002A, ULN-2003A, ULN-2004A)
Describes circuit capabilities and its use as an interface.
Sprague 7 pg.)

Communications

2 **"CRC 8030 Telephone DTMF Receiver"**
(CRC 8030)
Discusses dual-tone multi-frequency signaling. Includes specifications, test data, and interface capabilities.
Collins Application Note (28 pg.)

3 **"A Monolithic Microtransmitter'**
(LP2000)
Describes operation of the rf power generation, rf amplification, modulation and regulator portions of this IC suitable for HF to VHF, am/pulse modulation. Applications: 27 MHz AM transmitter, 72 MHz telemetery transmitter.
Lithic Systems Application Note LAN-102 (3 pg.)

4 **"Communication System Transmission Losses"**
Derives equations for computing insertion losses for components in a communication system. Gives computer generated tables, series resistance and reactance plus parallel resistance and reactance for various system impedances.
Motorola AN-710 (5 pg.)

5 **"A Unique Monolithic AGC/Squelch Amplifier"**
(LM170, LM270, LM370)
Describes operation of LM170. Applications: agc circuits with peak or with transistor detectors, squelch preamplifier with hysteresis, voice-operated-relay controls, Wein bridge oscillators, decade tunable oscillators, and a modulated 455 kHz signal generator.
National Linear Applications AN-51 (12 pg.)

6 **"SL600 Series—Integrated Circuits for Radio Communications"**
(SL600 Series)
Describes circuits and applications for the following: RF/IF amplifiers; limiting RF amplifier/detector; AGC generators; AF amplifier, VOGAD side tone amplifier; AM detector, AGC amplifier and SSB demodulator; multimode detector; microphone/headphone amplifier; double balanced modulators; and a square log device. Describes synchrodyne, superhet, SSB and multimode receivers; SSB and AM transmitters; SSB transceiver: a multi/mode transceiver and a Morse keyer.
Plessey Semiconductor Applications Manual (92 pg.)

7 **"Applications of CMOS Integrated Circuits and Communications Equipment"**
See listing under (Digital) CMOS. (Solid State Scientific)

8 **Modems**
See listings under (Digital) Data Transmission

Comparators

9 **"AM685/AM686/AM687 Designing with High Speed Comparators"**
(685, 686, 687)
Gives a mathematical analysis of circuit operation. Discusses use as a pulse detector, precision monostable and applications requiring hysteresis.
Advanced Micro Devices Application Note (10 pg.)

10 **"Varying Comparator Hysteresis without Shifting Initial Trip Point"**
Describes adding a positive feedback circuit to introduce precise variable hysteresis into the usual comparator switching action.
Burr-Brown AN-62 (1 pg.)

Comparators (cont)

11 **"The μA760—A High Speed Monolithic Voltage Comparator"**
(μA760)
Gives a functional description and cites typical performance characteristics. Discusses applications, including level detectors and line receivers, zero crossing detectors, high speed A/D converters, pulse width modulators, and fast peak detectors.
Fairchild Application Note 311 (8 pg.)

12 **"The μA750 Dual Comparator Subsystem"**
(μA750)
Discusses the circuit, design considerations and applications, including use in a combined heater/air conditioner control, a malfunction indicator, an analog status indicator and display, and a minimum frequency detector.
Fairchild Application Note 315 (7 pg.)

13 **"Voltage Comparator Applications Using the μA734"**
(μA734)
Discusses application of this comparator as a wide range phase meter, VCO, pulse width discriminator, free running oscillator, and sine wave frequency divider with phase adjustment.
Fairchild Applications Note 323 (3 pg.)

14 **"Radiation Testing of Linear Microcircuits"**
Includes the 702. See listing under (Linear) General. (Fairchild)

15 **"The Operation and Use of a Fast Integrated Circuit Comparator"**
(μA710, μA711)
Describes circuits of μA710 comparator and μA711 dual comparator. Discusses dc accuracy and response time of both. Discusses applications in line receivers, double-ended limit detectors, multivibrators, switching regulators, and switching power amplifiers. Appendices cover accuracy as a function of component matching, and test methods.
Fairchild Application Note 116 (14 pg.)

16 **"A High Speed Dual Differential Comparator—the MC1514"**
(MC1414, MC1514)
Describes circuit operation and applications, including level and limit detectors, multivibrators, line receivers, sense amplifiers, zero crossing pulse generator and a peak voltage detector.
Motorola AN-547 (13 pg.)

17 **"Precision IC Comparator Runs from 5V Logic Supply"**
(LM111, LM211, LM311)
Describes the LM111 circuit. Applications: photodiode level detector, zero crossing detectors, digital interface circuits, multivibrators, oscillators, and a frequency doubler. Includes application hints.
National Linear Applications AN-41 (6 pg.)

18 **"LM139/LM239/LM339 A quad of Independently Functioning Comparators"**
(LM139, LM239, LM339)
Describes LM139 circuit. Applications: comparators with hysteresis, limit comparators with lamp drivers, zero crossing detectors, oscillators, MOS clock drivers, wide range VCO, AND/NAND gates, OR/NOR gates, multivibrators, time delay generators, pulse width modulator, temperature alarm, tape reader and peak detector.
National Linear Applications AN-74 (16 pg.)

19 **"Fast Voltage Comparators with Low Input Current"**
(LM102, LM106, LM202, LM206, LM302, LM306)
Describes use of LM102 to buffer the input of the LM106 comparator. Applications: comparators for fast A/D converters, for zero crossing detectors, and for ac coupled signals.
National Linear Applications LB-6 (2 pg.)

20 **"An IC Voltage Comparator For High Impedance Circuitry"**
(LM111, LM211, LM311)
Describes LM111 circuit and comparison to LM106/LM710. Applications: zero crossing detector driving an analog switch, detector for a magnetic transducer, comparator for a low level photodiode, and driving a ground-referred load.
National Linear Applications LB-12 (2 pg.)

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Comparators (cont)

1 **"Specifying Selected Op Amps and Comparators"**
Discusses the most common parameters that are tested on operational amplifiers and comparators and the relative difficulty of testing on high speed equipment. Gives a guideline to tightened specifications.
National Linear Applications LB-26 (2 pg.)

2 **"Comparing the High Speed Comparators"**
(LM160, LM161, LM260, LM261, LM360, LM361)
Compares LM360 to μA760 and LM261 to NE529. Covers application as a peak detector for tape and disk file channels and in a high-speed 3-bit A/D converter.
National AN-87 (6 pg.)

3 **"Application of Programmble Micropower Comparators"**
(L161)
Describes the device and how to program it. Also describes the effects of programming on AC characteristics, limit, zero crossing, and level detectors; DC to DC converter applications.
Siliconix AN76-7

4 **"A Simple Comparator Using the HA2620"**
See listing under Amplifiers, Operational (Harris)

Consumer, AM/FM

5 **"A Fully Integrated High Quality AM/FM Stereo Receiver"**
(μA706, μA720, μA739, μA753, μA758, μA3075)
Describes receiver using ICs with a comparison to discrete design.
Fairchild Application Note 328/1 (6 pg.)

6 **"Integrated Circuits For FM Receivers"**
(μA703, μA753, μA758, μA3075)
Describes ICs capable of performing all basic functions of an FM stereo receiver, except the front end. Discusses 753 IF block, CA3075 2nd end IF block, 758 stereo multiplex decoder, 706 audio power amplifier.
Fairchild Application Note 318 (7 pg.)

7 **"The μA758, A Phase Locked Loop FM Stereo Multiplex Decoder"**
(μA758)
Gives functional description of this device, including input buffer/amplifier and bias supply, demodulator, stereo switch and lamp driver, VCO, frequency dividers, a pilot phase and amplitude detectors. Discusses operating characteristics, testing and alignment.
Fairchild Application Note 319 (11 pg.)

8 **"The μA732 and μA767 Integrated Circuit Stereo Multiplex Decoders"**
(μA732, μA767)
Discusses stereo demodulation, stereo/monaural switching, and interstation audio mute switching sections of these devices. Describes performance characteristics, external components required, alignment and user options.
Fairchild Application Note 286 (8 pg.)

9 **"An μA720—An AM Radio IC"**
(μA720)
Describes RF amplifier, oscillator, converter mixer, IF amplifier, AGC detector, and regulator of this IC. Discusses applications in automobile and table radios.
Fairchild Application Note 325 (7 pg.)

10 **"2 Watt Sound System"**
(ITT3701)
Describes the use of this FM Detector/Amplifier in FM and TV sound systems.
ITT Semiconductor 3701 Application Note (15 pg.)

11 **"Integrated Circuit IF Amplifiers For AM/FM and FM Radios"**
(MC1350, MC1355, MC1357, MFC4010, MFC6010)
Discusses the use of ICs in four IF amplifiers: a high performance FM, a guadrature detector FM, a composite AM/FM, and an economy model FM receiver.
Motorola AN-543A (14 pg.)

Consumer, AM/FM (cont)

12 **"A Complete Monolithic IF Strip for AM/AGC Applications"**
(LM172, LM272)
Circuit operation of LM172/LM272. Covers application in superheterodyne and low frequency T.R.F. receivers.
National Linear Applications Handbook, AN-15 (6 pg.)

13 **"Scanning Logic for RF Scanner-Receivers Using CMOS Integrated Circuits"**
See listing under CMOS (Motorola)

14 **"Audio Handbook"**
See listing under Consumer, Audio (National)

15 **"A Complete Monolithic AM/FM/SSB IF Strip"**
(LM273, LM373, LM274, LM374)
Discusses LM273/LM373, and LM274/LM374 IF amplifier/detectors. Includes description of FM, SSB, and AM detection. Applications include: FM slope detector, double conversion IF strip, and coherent phase locked receiver. Also includes application hints.
National Linear Applications AN-54 (8 pg.)

16 **"LM1800 (LM1310, LM1310E) Phase Locked Loop FM Stereo Demodulator"**
(LM1310, LM1800)
Describes this demodulator and discusses typical performance.
National AN-81 (11 pg.)

17 **"Low Cost IC Stereo Receiver"**
(LM1800, LM1820, LM3089)
Describes the complete circuit and performance of an AM/FM/Stereo receiver.
National AN-147 (4 pg.)

18 **"FM Remote Speaker System"**
Describes an FM transmitter which couples to its companion receiver thru the power lines. The system transmits speech or music and is suitable for home use as well as some factory applications.
National AN-146 (4 pg.)

19 **"A.M./S.S.B. Transceivers and Noise Blanking Using SL 1600 Series Circuits"**
(SL1623, SL1626, SL1640, SL1641)
Describes the sub-systems used in AM-SSB transceivers.
Plessey Semiconductor (10 pg.)

20 **"A S.S.B. Transceiver for Citizens' Ban Using Plessey SL1600 Integrated Circuits"**
(SL1600 series)
Describes the design of a SSB transceiver.
Plessey Semiconductor (4 pg.)

21 **"An A.M. Receiver Using the Plessey SL1600 Series"**
(SL1600 series)
Describes the design of a simple AM receiver.
Plessey Semiconductor (7 pg.)

22 **"SL1600 Series Transceiver Applications"**
(Sl600 series)
Discusses simple SSB and multimode transceiver design.
Plessey Semiconductors (32 pg.)

23 **"An IC for AM Radio Applications"**
(CA3088)
Describes CA3088E and application as a basic subsystem in AM broadcast receivers, as a 10.7 MHz IF amp, and as a general-purpose amplifier array.
RCA ICAN-6022

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Consumer, AM/FM

1 **"Integrated Circuits for FM Broadcast Receivers"**
(CA3005, CA3011, CA3012, CA3013, CA3014)
Discusses circuits for FM tuner, IF amplifier, limiter, and detector applications.
RCA ICAN-5269 (7 pg.)

2 **"Integrated-Circuit Frequency-Modulation IF Amplifiers"**
(CA3012, CA3028)
Describe CA3012 and CA3028 differential amplifiers and application in IF-Amplifier strips.
RCA ICAN-5380 (7 pg.)

3 **"Application of the RA3089E FM-IF Subsystem"**
(CA3089)
Discusses stability considerations and following circuits: quadrature-detector, audio and AFC, mute, tuning meter and rf-agc, if amplifier/detector system and stereo decoder. Also covers operation at frequencies other than 10.7 MHz.
RCA ICAN-6257 (8 pg.)

4 **"Integrated-Circuit Stereo Decoder Using the CA3090AQ Stereo Multiplex Demodulator"**
(CA3090AQ)
Gives circuit description. Describes the LC oscillator, reactance, stereo defeat, dc coupled flip-flop preamplifier and phase splitter circuits.
RCA ICAN-6259 (10 pg.)

Consumer, Audio

5 **"MOS Circuit for Electronic Organs"**
(S2193, S2470, S5255, S5256)
Describes the use of ICs for various electronic organ circuits
American Microsystems AP74-10 (7 pg.)

6 **"Applications of the μA739 and μA749 Dual Preamplifier Integrated Circuits In Home Entertainment Equipment"**
(μA739, μA749)
Describes circuit operation. Discusses d-c and a-c considerations, compensation and noise performance. Covers applications as a stereo tape amplifier, a high fidelity phonograph preamplifier, and a TV remote control amplifier.
Fairchild Application Note 171 (7 pg.)

7 **"A High Output Power, (5 Watt), Low Distortion, IC Audio Amplifier"**
(μA706)
Describes circuit, functions, design considerations of the μA706. Discusses application as an audio amplifier with the speaker load connected to ground, with the speaker load between supply and output, and discusses use in an FM stereo receiver.
Fairchild Application Note 317 (6 pg.)

8 **"Designing a Basic Organ System Using the MK50240"**
(MK50240)
Describes an organ system using the MK50240 Top Octave Generator for each octave.
Mostek (3 pg.)

9 **"LM380 Power Audio Amplifier"**
(LM380)
Describes the circuit and general operating characteristics. Applications: phono amplifier, bridge amplifier, and intercom.
National Linear Applications AN-69 (7 pg.)

10 **"Audio Handbook"**
(LM171, LM377, LM378, LM379, LM380, LM381, LM382, LM384, LM386, LM387, LM388, LM389, LM390, LM391, LM703, LM1303, LM1310, LM1351, LM1800, LM1820, LM2111, LM3011, LM3065, LM3075, LM3089, MM5837)
Contains discussions and design particulars on many areas including preamplifiers; AM, FM, and Stereo; power amplifiers; controls, networks and power supply design—covers practical as well as theoretical aspects.
National $4.00 (188 pg.)

Consumer, Audio (cont)

11 **"Application of the RCA-CA3007 Integrated-Circuit Audio Amplifier"**
(CA3007)
Describes circuit. Covers application as dual-supply audio driver in a direct-coupled audio amp, and as single-supply audio driver in a capacitor-coupled audio amp.
RCA ICAN-5037 (4 pg.)

12 **"Use of Analog Delay Lines for Audio Speed Change Without Pitch Changes"**
(SAD-1024)
Describes technique for increasing or slowing the speed of a recording.
Reticon Application Note No. 112 (4 pg.)

13 **"Build a Simple Comb-Filter or Flanger with a BucketBrigade Delay Line"**
(SAD-1024)
Describes a flanger (electronic sound modifier) and what is needed to build one.
Reticon Application Note No. 113 (4 pg.)

14 **"The ULN-2280 Amplifier"**
(ULN-2280)
Describes this single power amplifier circuit and discusses applications as a low-cost phonograph amplifier, amplifier with tone controls, common mode amplifier, full bridge amplifier, and a mono FM receiver.
Sprague Electric Microcircuit Application Report MAR 73-2 (8 pg.)

15 **"Low-Cost-Dual Class B Driver"**
(ULN-2277, ULN-2278)
Describes the ULN-2277/78 ICs and describes use in dual 2-watt and dual 15-watt amplifiers.
Sprague Electric Microcircuit Application Report MAR 73-5 (3 pg.)

Consumer, Medical

16 **"A Personalized Heart-Rate Monitor With Digital Readout"**
(MC1776, MC14013, MC14040, MC14572)
Describes digital heart-rate monitor using the MC1776 op amp and CMOS digital ICs.
Motorola AN-714 (4 pg.)

Consumer, TV

17 **"The μA780, μA781 and μA746 Integrated Circuit Color TV Chroma Processing System"**
(μA780, μA781, μA746)
Describes operation of μA780 chroma sub-carrier regenerator and μA781 chroma IF amplifier. Discusses their application along with the μA746 chroma demodulator as a complete IC chroma processing system for NTSC color TV receivers.
Fairchild Application Note 210 (10 pg.)

18 **"The μA746 Color TV Chroma Demodulator"**
(μA746)
Reviews NTSC color system, the requirements and the operation of a chroma demodulator. Describes circuit and function of this demodulator which contains two doubly-balanced synchronous detectors and a decoder matrix.
Fairchild Application Note 276 (5 pg.)

19 **"2 Watt Sound System"**
See listing under Consumer, AM/FM (ITT Semiconductor)

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Consumer, TV (cont)

1 **"Television Video IF Amplifier Using Integrated Circuits"**
(MC1330, MC1350, MC1352, MC1353)
Discusses requirements of the video IF section of a TV receiver. Describes MC1350/2/3 amplifier and MC1330 detector circuits. Includes design for a practical TV IF amplifier and detector.
Motorola AN-545 (11 pg.)

2 **"Video Amplifier Design: Know your Picture Tube Requirements"**
Describes video systems designed to alleviate design compromises associated with driving a unitized gun picture tube.
Motorola AN-761 (26 pg.)

3 **"Hybrid Modules For CATV Line Extender and Trunk Amplifiers"**
(MHW560, MHW561, MHW562)
Covers circuit, packaging, and thermal considerations of MHW560/1/and 2 hybrid modules.
Motorola AN-563 (5 pg.)

4 **"A Synthetic Spectrum Tuning System for TV"**
Describes a tuning system which generates a complete spectrum of TV channel markers to achieve precise tuning on any channel.
Motorola AN-739 (12 pg.)

5 **"Television Horizontal APC/AFC Loops: The Last 10 Percent"**
Discusses some of the common problems that may be encountered in the design of Horizontal APC/AFC loops and methods to avoid or overcome them.
Motorola AN-727 (15 pg.)

6 **"A Disassociated Intercarrier Television Video IF Amplifier"**
(MC1331)
Discusses a video IF system using the MC1331 low level multiplier detector.
Motorola AN-751 (9 pg.)

7 **"A Medium Cost PLL Varactor Tuning System Utilizing Off-the-Shelf Logic"**
Describes a frequency domain tuning scheme for varactor TV tuners.
Motorola AN-729 (14 pg.)

8 **"A Phase-Locked Loop Tuning System for Television"**
Describes a frequency domain tuning system using direct digital count down of the local oscillator.
Motorola AN-744 (10 pg.)

9 **"An approach to a Low-Noise TV IF System"**
(MC1331)
Discusses TV system noise figure and system trade offs, a technique to measure the IF contribution and ways to minimize the IF noise.
Motorola AN-765 (8 pg.)

10 **"The MC1323—A fully Programmable Demodulator"**
(MC1323)
Describes operation of this NTSC demodulator and use with various picture tube phosphors, especially color temperature D6500.
Motorola AN-763 (16 pg.)

11 **"Application of the RCA-CA3044 and CA3044V1 Integrated Circuits In Automatic-Fine-Tuning Systems"**
(CA3044)
Describes circuits, operating characteristics and dynamic performance of this wideband amplifier for AFC applications.
RCA ICAN-5831 (5 pg.)

12 **"Feedback-Type Volume-Control Circuits for RCA-CA3041 and CA3042 Integrated Circuits"**
(CA3041, CA3042)
Describes several types of volume controls for television receivers using these ICs, with a detailed discussion of feedback control.
RCA ICAN-5841 (4 pg.)

Consumer, TV (cont)

13 **"A Single IC for the Complete PIX-IF-System in TV Receivers"**
(CA3068)
Gives a detailed description of the circuit functions of the CA3068 and its use in color and b/w TV receivers.
RCA ICAN-6303 (17 pg.)

14 **"A Flexible Integrated-Circuit Color Demodulator for Color Television"**
(CA3067)
Describes circuit operation of the CA3067, including its output amplifiers, demodulator, demodulator preamp, and tint control amplifier. Describes use of this circuit in a red-green-blue system.
RCA ICAN-6724 (8 pg.)

15 **"Application of the CA3126Q Chroma-Processing IC Using Sample-And-Hold Circuit Techniques"**
(CA3126Q)
Detailed circuit description of this device, which requires only one adjustment; a trimmer capacitor to tune the crystal filter. Discusses performance data, the phase detector, sample and hold circuits, the VCO loop, first chroma amplifier and ACC servo loop, and the second chroma amplifier.
RCA ICAN-6247 (8 pg.)

16 **"Description and Application of the RCA-CA3120E Integrated-Circuit TV-Signal Processor"**
(CA3120)
Describes the operation and application of this device which includes TV video noise processor, agc and sync separator circuits.
RCA ICAN-6302 (9 pg.)

17 **"An Approach to a Unified Chroma System"**
Describes design approach that will eventually allow fabrication of a complete single-chip chroma system.
Sprague Electric TP 74-3 (9 pg.)

18 **"An Integrated Two-Watt Sound System For Television Applications"**
(ULN-2211)
Describes the design and use of the ULN2211 limiter-detector-amplifier.
Sprague Electric TP 72-05 (9 pg.)

19 **"The Type ULN-2214 TV-Sound System"**
(ULN-2214)
Detailed discussion of the design and performance characteristics of this FM limiter-detector-amplifier circuit.
Sprague Electric TP 75-4 (17 pg.)

Converters

20 **"Analog-Digital Conversion Handbook"**
This book covers most aspects of A/D and D/A converters including designing, testing and applying them. It also covers data systems, instrumentation amplifiers, muttiplexers and sample-holds.
Analog Devices $3.95 (400 pg.)

21 **"Beckman Model 845 Digital-to-Analog Converter"**
(845)
Discusses basic D/A converter performance including interface and transfer characteristics, then covers the performance of the 845 series.
Beckman Instruments (9 pg.)

22 **"Sample and Hold, Or High-Speed A/D Converters, How Do You Decide?"**
Uses 64-channel digital data-acquisition system as an example to discuss tradeoffs between converters. Covers dependency of sampling rate on input bandwidths, evaluation of system error budgets, and determination of the maximum system aperture.
Burr-Brown AN-56 (4 pg.)

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Converters (cont)

1 **"D/A Converter Differential Linearity Error—It Really Shows Up"**
Discusses differential linearity, the difference in analog output for a change between two successive digital input codes. Gives graphs of two examples with the same linearity specification.
Burr-Brown AN-58 (2 pg.)

2 **"Don't Forget D/A Converter Tempco"**
Discusses offset, gain and linearity drift with temperature.
Burr-Brown AN-59 (3 pg.)

3 **"Principles of Data Acquisition and Conversion"**
Discusses basic principles of analog to digital systems including sampling rate, aperture error, accuracy, resolution, throughput, and codes.
Burr-Brown AN-79 (5 pg.)

4 **"FX-209 AP Notes"**
(FX-209)
Describes use of the FX-209 delta modulation analog to digital converter as an AGC amplifier, audio delay line and as an audio scrambler.
CMA (6 pg.)

5 **"Graphs Give Aperture Time Required for A-D Conversion"**
Presents two graphs, aperture time versus rate of voltage change and versus frequency, for resolutions from 4 to 16 bits.
Datel Technical Note V-14 (4 pg.)

6 **"Know your Converter Codes"**
Describes the various A/D and D/A converter codes.
Datel Bulletin V-12 (6 pg.)

7 **"Applications of the μA9650 4-Bit High Speed Precision Current Source"**
(9650)
Describes electrical characteristics, input circuit design considerations, basic biasing. Covers applications, including 8, 10, and 12-bit D/A and A/D converters, sample and hold circuits, servo or tracking converters and voltage-to frequency converters.
Fairchild Application Note 324 (15 pg.)

8 **"Counter Type A to D Converter"**
(HI1080)
Circuit details of an A to D converter employing a unidirectional digital counter and the HI-1080 eight-bit D to A converter to generate a ramp voltage.
Harris Application Note 512 (3 pg.)

9 **"Digital-to-Analog Converter Applications"**
(HI1080, HI1085)
Operating modes and applications of HI-1080 converter, which features resistor ladder network and switching devices on same chip. Discusses cascaded D to A converter as well as up-down counter and successive approximation A to D converters.
Harris Application Note 511 (7 pg.)

10 **"A-8400 User Guide"**
(A8400)
Theory, circuit details, operation, and design examples of this v/f and f/v converter.
Intech (18 pg.)

11 **"Digital To Analog Converter Circuits Using the 8018A"**
(8018A, 8019A, 8020A)
Discusses D/A converters, both in general and their electrical specifications. Describes circuit operation for 8018A and covers its expansion to 8 and 12 bit units. Also discusses generating reference currents using zeners, pnp transistors or high-gain operational amplifiers as references. Describes system interface requirements.
Intersil Application Bulletin A010 (8 pg.)

Converters (cont)

12 **"Voltage Transients (Glitches)"**
(MN3008)
Discusses D/A converter analog voltage spikes appearing in the output following a change of input code.
Micro Networks AN-101 (2 pg.)

13 **"Truncation of A/D Converters"**
Describes how to reduce or to program the number of bits converted.
Micro Networks AN-102 (2 pg.)

14 **"When Should a Sample Hold Amplifier Be Used?"**
Covers the use of sample-hold amplifiers with A/D converters. Discusses use with dynamically changing signals and the droop rate of the sample-hold circuit.
Micro Networks AN-103 (2 pg.)

15 **"MN312 Connections for Bipolar Output"**
((MN312)
Shows use of an external op amp to convert a unipolar output to bipolar.
Micro Networks AN-104 (2 pg.)

16 **"Serial to Parallel Conversion"**
(MN502, MN5200, MN5210)
Covers timing considerations in the conversion of A/D converter output from serial to parallel form.
Micro Networks AN-106 (2 pg.)

17 **"Simplifying the Digital to Analog Converter through Hybrid Technology"**
Considers basic design problems of D/A converters and gets into hybrid design. Includes construction techniques, specifications and testing.
Micro Networks (10 pg.)

18 **"Analog-To-Digital Cyclic Converter"**
(MC1456)
Discusses circuits and operation of medium speed-medium accuracy converter that uses successive approximation technique in which unknown analog input voltage is successively compared to reference voltage to determine each bit of digital output. A comparison of gray and binary code operation and an error analysis are provided.
Motorola AN-557 (10 pg.)

19 **"A Single Ramp Analog-To-Digital Converter"**
Discusses an A/D converter which incorporates a calibration cycle to insure 12 bit accuracy. Briefly covers errors encountered in the converter described.
Motorola AN-559 (9 pg.)

20 **"Generate Custom Waveforms Digitally"**
(MC1406, MC1458, MC74193)
Describes method using a read only memory and off-the shelf ICs, including MC74193 TTL up-down counter, MC1406L D/A converter, and MC1458CP, which acts as output buffer and polarity switch. Applications include standard as well as non-standard waveforms.
Motorola AN-589 (5 pg.)

21 **"High Speed Digital-To-Analog and Analog-To-Digital Techniques"**
Gives overview that includes voltage and current output D/As; parallel (flash), tracking, successive approximation, and parallel ripple A/Ds as well as nonsynchronous and synchronous VTF A/D, Glossary of terms.
Motorola AN-702 (14 pg.)

22 **"Analog-To-Digital Conversion Techniques"**
Discusses open-loop and feedback techniques: frequency, pulse width, cascade, ramp, counter, successive approximation, multiple comparison subranging, nonlinear conversion, double and triple ramp conversion.
Motorola AN-471 (21 pg.)

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Converters (cont)

1 **"Successive Approximation A/D Conversion"**
(MC1408, MC14559)
Describes advances in successive approximation techniques with emphasis on SARs (Successive Approximation Registers.) Shows both a normal and a high speed A/D using these methods.
Motorola AN-716 (8 pg.)

2 **"Analog-To-Digital Conversion Techniques with the M6800 Microprocessor System"**
See listing under (Microprocessor) Systems (Motorola)

3 **"Binary D/A Converters Can Provide BCD-Coded Conversion"**
See listing under (Digital) Converters (Motorola)

4 **"Binary-to-BCD and BCD-to-Binary Conversion with Complex IC Functions"**
See listing under (Digital) Converters (Motorola)

5 **"Applications of the MC1405/MC14435 in Digital Meters"**
See listing under Instrumentation (Motorola)

6 **"Logarithmic Converters"**
See listing under Amplifiers, Operational. (National)

7 **"Data Acquisition System Interface to Computers"**
(AD1200, AD1210, MM5357)
Compares three configurations for multiple input analog to digital converter systems—Random Addressed Multiplexed, Parallel Conversion, and Multiplexed with Memory. Gives detailed comparisons of costs, A/D and interface requirements.
National AN159 (18 pg.)

8 **"Digital Voltmeters and the MM5330"**
(MM5330)
Describes basic counting techniques for building digital voltmeters and shows how the MM5330 can be used in a dual slope system.
National AN-155 (8 pg.)

9 **"Specifying A/D and D/A Converters"**
Explains and defines the data sheet terms for these converters.
National AN-156 (6 pg.)

10 **"Low Cost, High Speed Analog-to-Digital Conversion with the DAC-08"**
(DAC-08)
Discusses the successive approximation technique to A/D and describes three designs with conversion times of 1, 2, and 4 μ sec.
Precision Monolithics AN-16 (7 pg.)

11 **"A Low Cost, Easy-to-Build Successive Approximation Analog-to Digital Converter"**
(DAC-100, CMP-01)
General discussion of feedback A/D converters. Operation of A/D converter capable of 8-bit conversions in 6 us. The system is expandable to 10-bit resolution. It uses DAC100, CMP-01, and a successive approximation register.
Precision Monolithics AN-11 (8 pg.)

12 **"Interfacing Precision Monolithics Digital-to-Analog Converters with CMOS Logic"**
(DAC-100, DAC-01)
Analyzes input circuits of these DACs and CMOS interfaces. Describes a complete 10-bit DAC and an 8 bit A/D.
Precision Monolithics AN-14 (4 pg.)

13 **"A Low Cost, High-Performance Tracking A/D Converter"**
(DAC-100, CMP-01)
Basic operation of 8-bit tracking converter that uses DAC100 series 10-bit D/A converter, CMP-01 series comparator, and 4-bit MSI up/down counters.
Precision Monolithics AN-6 (8 pg.)

Converters (cont)

14 **"DAC-08 Applications Collection"**
(DAC-08)
Discusses the dual output, and high compliance. Covers use in a CRT display driver, bridge transducer control system, A/D converter, waveform generator, digital addition/subtraction with analog output, digital attenuator and microprocessor controlled A/D converter.
Precision Monolithics AN-17 (12 pg.)

15 **"Strobing the DAC-08 under Logic Control"**
(DAC-08)
Gives connections for strobing the output of this DAC
Precision Monolithics AB-001 (1 pg.)

16 **"Digital-to-Analog Conversion Using the RCA-CD4007A COS/MOS IC"**
(CD4007A)
Discusses resistance networks for DAC's and a voltage-follower amp for single-supply operation. Describes a 9-bit COS/MOS DAC.
RCA ICAN-6080 (6 pg.)

17 **"The 4151 Voltage to Frequency Converter"**
(RC4151, RM4151, RV4151)
Describes various uses of this v/f and f/v converter.
Raytheon Semiconductor Application Note (8 pg.)

18 **"Function and Application of 3 1/2 Digit A/D Converter Set"**
(LD110, LD111)
Describes the operation of the LD110 digital processor and the LD111 analog processor. Various DVM circuits are shown including circuits for ratio, current, ac voltage and frequency measurements. A detailed error analysis is provided.
Siliconix Application Note AN74-1 (12 pg.)

19 **"Applying the LD130 ± Digit A/D Converter"**
(LD130)
Discusses device features and its use in displays, interface, and instrumentation.
Siliconix AN76-5 (16 pg.)

20 **"Using the 4130 ADC Series, 4855 Sample-Hold, and the 4550 Multiplexer in High Speed Data Acquisition Systems"**
(4130, 4855, 4550)
Analyzes various system configurations and discusses design considerations.
Teledyne Philbrick AN-19 (7 pg.)

21 **"Solve Your Measurement Problems"**
Discusses v/f and f/v converters and their use in data acquisition problems.
Teledyne Philbrick AN-20 (6 pg.)

22 **"Designing High Speed Data Acquisition Systems"**
Discusses the basics of data acquisition systems; focusing on sample-and-hold circuits and multiplexer modules.
Teledyne Philbrick AN-21 (12 pg.)

23 **"How to Specify and Test Voltage to Frequency and Frequency to Voltage Converters"**
Defines device parameters, specifications, and test techniques.
Teledyne Philbrick AN-22 (4 pg.)

24 **"Specifying and Testing Analog to Digital Converters"**
Defines the basic parameters, specifications, and test methods.
Teledyne Philbrick AN-24 (7 pg)

Drivers

25 **"PIN Diode Drivers"**
See listing under Switches. (National)

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Drivers (cont)

1 **"CMOS Line Drivers"**

States reasons for using CMOS line drivers.
2 National AN-158 (4 pg.)

"Driver Circuits for the JFET Analog Switch"

See listing under Switches. (Siliconix)

3 **"Logic to Power Converter Circuits"**

(400-series, 500-series)
Covers the operation of the 400 and 500 high current driver series.
Sprague Electric TP 71-3 (6 pg.)

4 **"Monolithic Memory Driver"**

(SN75324)
Describes this monolithic memory driver and illustrates its use in addressing and driving a magnetic memory. Notes on circuit-board precautions and proper operation are provided.
Texas Instruments Application Report CA-107 (6 pg.)

Followers

5 **"A Fast Integrated Voltage Follower with Low Input Current"**

(LM102)
Circuit description. Use of the LM102 for analog commutator, sample and hold, ac amplifier and active filter applications.
National Linear Applications Handbook, AN-5 (11 pg.)

6 **"The LM110—An Improved IC Voltage Follower"**

(LM110, LM210, LM310)
Compares LM102 and LM110 circuits. Shows diagrams of LM110 as a high pass active filter, high Q notch filter, bandpass filter, and low drift sample and hold circuit.
National Linear Applications LB-11 (2 pg.)

7 **"Monolithic Operation Amplifiers—The Universal Linear Component"**

See Amplifiers. Operational (National)

8 **"Applications for a New Ultra-High Speed Buffer"**

(LH0033, LH0033C)
Describes LH0033 fast voltage follower/buffer. Applications; high speed dual limit comparator for MOS logic, instrumentation shield/line driver, high speed sample and hold circuit, 4.5 MHz notch filter, high input impedance AC coupled amplifier, output buffer.
National Linear Applications AN-48 (4 pg.)

General

9 **"Nonlinear Circuits Handbook"**

Covers principles, circuits, performance, specifications, testing and applications for multipliers, dividers, squares, log circuits, multifunction and rms-to-dc converters.
Analog Devices $5.95 (535 pg.)

10 **"Custom IC Design Using I^2L Technology"**

See Digital-I^2L (Exar)

11 **"Radiation Testing of Linear Microcircuits"**

(μA702, μA709, μA710, μA711)
Describes tested performance of μA702 and μA709 operational amplifiers and μA710 and μA711 comparators after having been irradiated with fast neutrons of energies greater than 0.01 MeV.
Fairchild Application Note 195 (13 pg.)

General (cont)

12 **"Solid State Gas/Smoke Detector Systems"**

Describes semiconductor and ionization chamber systems with some discussion of the use of these with CMOS ICs.
Motorola AN-735 (9 pg.)

13 **"CMOS Linear Applications"**

See listing under (Digital)
CMOS National

14 **"Constant Current LED"**

See listing under Regulators (National)

15 **"MOS Analog Function Generator"**

Describes using MOS devices to construct an Analog Function Generator. The coding is stored in ROM.
National MOS Brief 3 (2 pg.)

16 **"Surface Acoustic Wave Technology"**

Presents surface acoustic wave fundamentals and use in delay lines, pulse compression filters, bandpass filters, oscillators and discriminators.
Plessey Semiconductor (10 pg.)

17 **"Solid-State Devices Manual"**

Provides tutorial information on discrete devices and ICs, with emphasis on consumer, hobbyist and experimenter applications.
RCA SC-16 $5.00 (750 pg.)

18 **"IMP-16L DMA—What It Is and How to Use It"**

(IMP-16)
Discusses general theory of the DMA Bus; gives examples of priority expansion and data transfer.
National AN-135 (6 pg.)

19 **"Linear Applications, Vol 1"**

Feb. 1973, includes National application notes (AN) 1-6, 8, 10, 13, 15, 20, 21, 23, 24, 28-34, 38, 41, 42, 46, 48, 49, 51, 53, 54, 56, 63, 64, 69-72, 74, 75 and Linear Briefs (LB) 1-20, individually described elsewhere. National $4.00 (432 pg.)

20 **"Linear Applications, Vol 2"**

Includes National application notes (AN) 79, 81, 82, 87, 88, 97, 103, 104, 110, 115, 116, 125, 129, 132, 146, 147, 151, 153, 154, 156, 161, 162 and Linear Briefs (LB) 1-34, individually described elsewhere.
National $4.00 (256 pg.)

21 **"Linear Integrated Circuits"**

Basic circuit elements, fabrication, packaging, and interconnection techniques are discussed. Data and application information on RCA linear IC's is included.
RCA IC-41 $2.50 (416 pg.)

Industrial Control

22 **"Electronic Controller with an Equilibrium Sustaining Mode"**

(3500 series)
Discusses a controller formed with two operational amplifiers in a pulse width modulation circuit with feedback. The feedback operates from a heater hrough the medium being heated to sense amplifiers.
Burr-Brown AN-63 (2 pg.)

23 **"Sequential Industrial Contol Using the IM5200 FPLA"**

(IM5200)
Describes theory and advantages of using this FPLA, Example included.
Intersil Application Bulletin MB0001 (6 pg.)

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Industrial Control (cont)

1 **"Variable Speed Control System For Induction Motors"**
(MC673, MC688)
Describes control scheme implemented with discrete components and IC logic coupled by an LED and a photo transistor. Gives example of a circuit used to drive a Class F, 60 Hz, permanent-split, capacitor induction motor with a 13 oz. in. load rating.
Motorola AN-575A (5 pg.)

2 **"A ROM-Digital Approach to PWM-Type Speed Control of AC Motors"**
Describes a pulse width modulation scheme to control motor speed. Shows a CMOS-ROM system to provide variable frequency drive for 1, 2, or 3 phase motors.
Motorola AN-733)12 pg.)

3 **"A Variable Frequency Control for 3Φ Induction Motors"**
Describes a variable frequency, variable voltage drive system for 3-phase induction motor controls.
Motorola AN-766 (10 pg.)

4 **"Temperature Measurement Method Based on Matched Transistor Pair Requires No Reference"**
(MAT-01, OP-10)
Discusses properties of matched transistor pairs, then describes temperature measuring systems built with a matched pair, constant current sources, and a differential amplifier (OP-10)
Precision Monolithics, AN-12 (8 pg.)

5 **"Signetis Analog Manual"**
(μa723, LM381, LM382, MC1488, MC1489, MC1496, PA239, ULN2111, 521, 522, 526, 527, 529, 540, 542, 550, 555, 560, 561, 562, 565, 566, 569, 592)
Covers linear IC processing and design, operational amplifier characteristics and applications, voltage regulators, interface circuits, timers, communications circuits, consumer circuits, phase locked loops, and DMOS devices (314 pg.) and data sheets (321 pg)
Signetics $5.95 (635 pg.)

Instrumentation

Also see Converters

6 **"Monolithic Thermal Converter Permits Wideband RMS AC Measurement"**
Describes (4131) monolithic thermal converter with a matched pair of npn transistors and diffused resistors. Discusses application as rms to dc converter and rms-voltage regulation.
Burr-Brown AN-76 (6 pg.)

7 **"Application Notes AN-205"**
(FX205)
Describes use of the FX205 psuedo sinewave generator as a tone generator, tone-burst generator, a divide by eight sinewave source and an fsk generator.
Consumer Microcircuits of America AN-205 (16 pg.)

8 **"A Digital Voltmeter Using the AY-5-3507"**
(AY5-3507)
Gives schematics for the analog section, reference voltage generator, clock oscillator, and display circuitry required in addition to this logic IC to build a 3½ digit voltmeter.
General Instrument Microelectronics (5 pg.)

9 **"A Precision Waveform Generator and Voltage Controlled Oscillator"**
(8038)
Discusses the 8038 circuit and operation. Covers external adjustments, power-supply connections, frequency modulation, sweeping, and use in phase locked loops.
Intersil Application Bulletin A012 (8 pg.)

Instrumentation (cont)

10 **"A Synchronously Gated N-Decade Sweep Oscillator"**
(MC838P, MC856P, MC3061P)
Describes prototype oscillator that can be swept over five decades. Discusses options that allow preselection of any one, two or five frequency decades between 10 Hz and 10 MHz, whether sequential or not.
Motorola AN-540 (13 pg.)

11 **"Applications of MC1405/MC14435 in Digital Meters"**
(MC1405, MC14435)
Provides a detailed applications reference for this two chip, dual slope A/D converter system.
Motorola AN-748 (18 pg.)

12 **"A 3½ Digit DVM Using an Integrated Circuit Dual Ramp System"**
(MC1405, MC14435)
Describes a complete digital voltmeter based on the MC1405/14435 device pair. Includes input buffers and autopolarity.
Motorola AN-746 (6 pg.)

13 **"Generate Custom Waveform Digitally"**
See listing under Converters. (Motorola)

14 **"A Fully Differential Input Voltage Amplifier (Instrumentation Amplifier)"**
(LM3900)
Describes operation of instrumentation amplifier built with LM3900. Also shows how a transducer bridge amplifier system can be developed with LM3900.
National Linear Applications LB-20 (2 pg.)

15 **"Precise Tri-Wave Generation"**
(LM118, LM119)
Describes triangle-wave generator consisting of the LM118 integrator and two LM119 comparators. Discusses applications including VCO, regulator and operational amplifier testing.
National Linear Brief-23 (2 pg.)

16 **"Solid State Altimeter for Transponder Applications"**
(LX3702)
Describes a solid state altimeter using a pressure transducer. The unit provides an altitude transmission code for use with transponders, plus digital readout.
National Transfucer Handbook AN-109 (8 pg.)

17 **"Wide Range Function Generator"**
Construction a function generator for sine waves as well as square and triangular waveforms that operates below 10 Hz up to 1 MHz, with usable output to approximately 2 MHz. Design technique; circuit design, and construction directions.
National AN-115 (4 pg.)

18 **"Build an Autoranging DMM with the Ld130 A/D Converter"**
(LD130)
Discusses the construction of a DMM using the device.
Siliconix DA76-3 (7 pg.)

19 **"Opto-Electronic Fault Indicator for Logic Circuits"**
Proposes use of visible-light-emitting-diodes (VLEDHs) as logic indicators. Discusses VLED characteristics, applications and typical circuits.
Texas Instruments Application Report CA-153 (4 pg.)

20 **"EPN2100 Thermal Printer"**
(EPN2100)
Detailed discussion of this solid state thermal printer and its interface requirements.
Texas Instruments Application Report CA-163 (6 pg.)

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Instrumentation (cont)

1 **"EPN2500 Thermal Printer"**
(EPN2500, SN74492, SN74495, TMS2502)
Discusses this thermal printer and its interface requirements. Includes a description of the SN75495 Row Driver and the SN75492 Digit Driver to interface the printhead to MOSFET logic circuits, and the TMS2502 character generator for providing alphanumeric characters.
Texas Instruments Application Report CA-175 (10 pg.)

Modulators

2 **"MC1596 Balanced Modulator"**
(MC1496, MC1596)
Describes device operation and applications, including modulators and demodulators for AM, SSB, and suppressed carrier AM; frequency doublers; and HF/VHF double balanced mixers.
Motorola AN-531 (12 pg.)

Multipliers

3 **"AD530 Complete Monolithic Multiplier, Divider, Square Rooter"**
(AD530)
Describes the device, its circuit, external connections and adjustments. Applications include use in a precision rectifier, a phase sensitive demodulator, an automatic level control, a voltage controlled filter, a voltage controlled oscillator, an amplitude modulator and a frequency discriminator.
Analog Device Technical Bulletin (11 pg.)

4 **"A Practical Guide to Applying IC Multipliers"**
Describes theory, gives definitions, covers use in dividers, squares, vector summation, rms to dc conversion, 2ϕ oscillator, and balanced modulators.
Analog Devices (11 pg.)

5 **"Reducing the Total Error of the AD530, AD531, AD532, and AD533 Multipliers"**
(AD530, AD531, AD532, AD533)
Describes method of empirically reducing errors using external resistors.
Analog Devices Application Brief (2 pg.)

6 **"Analog Modules Multiply User's Options"**
Discusses various types of multipliers, logarithmic converters, dividers and square rooters, peak detectors and comparing circuits. Applications: electron beam welder, 3-mode carriage control, position control, fog visiometer, optical measuring system, and lab pressure standard.
Burr-Brown AN-55 (6 pg.)

7 **"A Primer on Analog Multiplier Specifications"**
Discusses dc and dynamic performance specifications, including output and input offset, gain error, linearity, small signal and full power frequency response, output slewing rate, and settling time.
Burr-Brown AN-51 (6 pg.)

8 **"Using IC Multipliers"**
Covers the use as a divider, square root generator, polynomial generator, sine generator, voltage tuned filter. Cites some applications where other ICs should be chosen.
Burr-Brown AN-73 (4 pg.)

9 **"Analog Shaping"**
(4301)
Describes the use of the 4301 multifunction circuit which has the transfer function XY/Z. Includes rms to dc conversion, exponentiation, trigonometric functions, vector computation, and use as a log amp.
Burr-Brown AN-70 (5 pg.)

Multipliers (cont)

10 **"Analysis and Basic Operation of the MC1595"**
(MC1495, MC1595)
Gives equations for the analysis of this linear four-quadrant multiplier and discusses characteristic performance. Covers multiplication, division, mean squares, square roots, roots and powers.
Motorola AN-489 (14 pg.)

11 **"Wideband Amplifier/Multiplier"**
(SG1402)
Operation and applications of the SG1402. Describes use as a single-ended variable gain amplifier, a modulator, and a demodulator.
Silicon General Linear IC Product Guide (4 pg.)

Phase Locked Loops

12 **"Precision PLL System Using the XR2207 and the XR2208"**
(XR2207, XR2208)
Defines phase locked loop parameters and describes this two-chip PLL system. Includes circuit interconnections for both single supply and split-supply operation. Also gives PLL design equations.
Exar TB-1002 (6 pg.)

13 **"The μA758, a Phase-Locked Loop FM Stereo Multiplex Decoder"**
See listing under Consumer, AM/FM. (Fairchild)

14 **"Introduction to the Phase Locked Loop"**
(HA-2820)
General discussion of phase locked loops. Describes applications including a bandpass filter, FM receivers, data modems and synchronizers, a motor speed control, and a frequency synthesizer. Discusses features of HA-2800 and 2820 PLL.
Harris Application Note 601 (7 pg.)

15 **"A General Analysis of the Phase Locked Loop"**
Discusses a linear model, stability considerations and steady state response for phase locked loops.
Harris Application Note 602 (8 pg.)

16 **"The HA-2820/2825 Low Frequency Phase Locked Loop"**
(HA-2820, HA-2825)
Explains circuitry of these phase locked loops in 0.1 Hz to 3 MHz operation. Discusses methods for obtaining parameters of a linear model from device's performance curves. External connections are illustrated with an FM demodulator circuit.
Harris Application Note 605 (7 pg.)

17 **"A Frequency Synthesizer For Aircraft Automatic Direction Finding Systems"**
(MC4016, MC4044, MC1658)
Describes a phase locked loop frequency synthesizer, which includes a MC4016 programmable decade counter, a MC4044 phase detector, and a MC1658 voltage controlled multivibrator.
Motorola AN-594 (10 pg.)

18 **"A New Generation Of Integrated Avionic Synthesizers"**
Discusses several different types of servo phase locked loop systems and describes a synthesizer for avionic equipment.
Motorola AN-553 (9 pg.)

19 **"MTTL and MECL Avionics Digital Frequency Synthesizer"**
Describes phase detector, emitter coupled oscillator, prescaler, programmable counter and giver phase locked loop analysis, for a 118 MHz to 136 MHz synthesizer.
Motorola AN-532A (10 pg.)

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Phase-locked Loops (cont)

1 **"Phase-Locked Loop Design Fundamentals"**
(MC4016, MC4024, MC4044, MC4316, MC4324, MC4344)
Outlines fundamental design concepts for phase locked loops implemented with ICs. Gives equations using Laplace Transforms needed to evaluate the basic loop performance and briefly describes a design using MC4000 series devices.
Motorola AN-535 (11 pg.)

2 **"An ADF Frequency Synthesizer Utilizing Phase-Lock-Loop ICs"**
(MC1648, MC3062, MC4016, MC4018, MC4044, MC7400)
Describes circuit for a synthesizer suitable for the local oscillator function in aircraft Automatic Direction Finder equipment. Covers programming, trouble shooting, power supply requirements, performance, circuit modifications, and circuit construction.
Motorola AN-564 (9 pg.)

3 **"Crystal Switching Methods for MC12060/MC12061 Oscillators"**
(MC12060, MC12061)
Discusses methods of using diodes as rf switches to select crystals for these oscillators. The techniques are useful for electronic selection of one of a group of crystals with minimum distrubance to the series resonant frequency of the selected crystal.
Motorola AN-756 (5 pg.)

4 **"A Medium Cost PLL Varactor Tuning System Utilizing Off-the-Shelf Logic"**
See listing under Consumer, TV (Motorola)

5 **"A Phase-Locked Loop Tuning System for Television"**
See listing under Consumer, TV (Motorola)

6 **"The Phase Locked Loop IC as a Communication System Building Block"**
(LM565, LM1496, LM1596)
Discusses basic phase locked loop operation, design considerations, noise performance and describes the LM565 circuit. Applications; IRIG channel demodulator, FSK demodulator, and weather satellite picture demodulator.
National Linear Applications AN-46 (12 pg.)

7 **"SL650 Phase-Locked Loop Applications"**
(SL650, SL651)
Describes the circuit and application of this device that can operate to 0.5 MHz. Applications: Modulators-AM, FM, FSK, PAM, SCAM, tone burst, phase shift, delta, PWM, Waveform Generators-sine, triangle, mark/space ratio, staircase; Demodulators; Modem Systems, and a Digital Voltmeter.
Plessey Semiconductor SL650 Applications (32 pg.)

8 **"Low-Power Digital Frequency Synthesizers Utilizing COS/MOS ICs"**
(CD4000 Series)
Reviews digital phase-locked loops. Describes their implementation with CMOS for use in FM receiver synthesizers, both heterodyne and prescaling types.
RCA ICAN-6716 (15 pg.)

9 **"The RCA COS/MOS Phase-Locked-Loop—A Versatile Building Block for Micro-Power Digital and Analog Applications"**
(CD4046)
Discusses fundamentals of phase-locked-loops. Presents a detailed description of the CD4046A. Describes applications, including FM demodulators, frequency synthesizers, split-phase data synchronizers and decoders, and lock detection.
RCA ICAN-6061 (8 pg.)

10 **"Applications of the COS/MOS CD4059A Programmable Divide-by-N Counter: Digital Frequency Synthesis for FM Tuners and CD Transceivers"**
(CD4059)
Discusses frequency synthesis using the counter for an FM digital tuner and a CB transceiver.
RCA ICAN-6374 (12 pg.)

Photosensitive Devices

11 **"Light Sense"**
Covers optoelectronic sensors and systems including light activated switches and selfscanned photodiode arrays.
Integrated Photomatrix $6.00 (147 pg.)

12 **"Applications of Reticon Photodiode Arrays in Electron and X-Ray Detectors"**
(RL Series)
Describes the use of self-scanning photodiode arrays for detecting soft X-rays (1 to 10A) and electrons in the 10 to 100 KeV range.
Reticon Application Note 101 (4 pg.)

Power Control

13 **"A Monolithic Zero-Crossing AC Trigger /Trigac) for Thyristor Power Controls"**
(μA724)
Describes the μA742 zero-crossing ac trigger, which minimizes radio frequency interference generation. Discusses the circuit and operation of this device. Covers application with an SCR in a half wave circuit, full wave circuits, isolated system connections, and multi-phase power systems.
Fairchild Application Note 208 (5 pg.)

14 **"Servo Motor Drive Amplifiers"**
Discusses design of transformerless, AC servo amps using power Darlington transistors and IC op amps. Describes two power amplifiers, one using a 28 v. power supply, the other, high voltage transistors. Also covers four op amp preamps and 90° phase shifters.
Motorola AN-590 (7 pg.)

15 **"Pulse Width Modulation For Small DC Motor Control"**
(MC1458, MC1709, MC14011)
Discusses several circuits, using discrete, operational amplifier and IC devices, for developing pulse width modulation drive signals. Describes how these signals can control the speed of small motors, primarily permanent magnet types.
Motorola AN-705 (4 pg.)

16 **"Power Control Using the Zero Voltage switch"**
(MFC8070)
Discusses zero voltage detector, pulse gate, input control, and charging circuit sections of the MFC8070. Describes application in a temperature controller that incorporates CMOS logic and optical couplers.
Motorola AN-597 (7 pg.)

17 **"A 20 KHz, 1 KW Line Operated Inverter"**
Describes application in 208-volt, line-operated, computer main-frame power supply. The output capability of the inverter is 5 v at 200 amp.
Motorola AN-588 (6 pg.)

18 **"Phase Control of AC Power with the SL440"**
(SL440)
Describes the operations of the SL440 power control circuit, and supply requirements. Applications include use with inductive loads, three phase systems, lighting, heating, motor and power supply control.
Plessey Semiconductor (38 pg.)

19 **"Power Switching Using Solid-State Relay"**
(CA3059)
Discusses advantages of triac over electro-mechanical relays. Covers basic parameters, such as surge-in-rush currents, transient-voltages, suppression networks, turn-off considerations, and various modes of triac gating.
Also discusses ac power control by various circuit designs for ON/OFF control, zero-voltage switching, and line-voltage isolation.
RCA AN-6141 (5 pg.)

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Power Control (cont)

1 **"Triac Power Controls For Three-Phase Systems"**
(CA3059)
Describes basic approach to designing triac control circuits for use in the switching of three-phase power. Outlines basic design rules and describes CA3059 zero-voltage switch. Discusses methods of isolation of dc logic circuitry. Covers recommended configurations for power control circuits.
RCA AN-6054 (6 pg.)

2 **"Solid-State Approaches To Cooking Range-Control"**
(CA3059, CA3080, CA3079, CD4013, CD4015)
Discusses application of ICs to cooking range control, both top burner and oven/broiler controls. Covers low-resistance sensors, zero-voltage switching and central processor control.
RCA AN-6096 (8 pg.)

3 **"Some Applications of a Programmable Power Switch/Amplifier"**
(CA3094)
Brief circuit description of CA3094. Device delivers three watts average power, 10 watts peak power to external load. Applications include Class A power amplifiers and driver amplifiers for complementary transistors, wideband power multivibrators, oscillators, comparators, voltage regulators, analog timers, and motor-speed controllers.
RCA ICAN-6048 (12 pg.)

4 **"Features and Applications of RCA IC Zero-Voltage Switches"**
See listing under Switches. (RCA)

5 **"A Monolithic Amplifier-Detector SCR Firing Circuit"**
(ULN-2300)
Describes the operation of the ULN-2300 linear differential amplifier with integral SCR. Covers response, impedance characteristics and closed loop characteristics, open loop gain vs. temperature, and describes use as a sensitive control, as a drive amplifier in a typical control system and as a control for counters, relays, motors.
Sprague Electric TP69-4 (12 pg.)

9 **"Applications of High-Voltage/High-Current Monolithic Interface Circuits"**
(060, 400 Series, 500 Series)
Application of Series 060 Dual Darlington Switch and Series 400/500 Power Drivers in aircraft lamp drive circuit, solenoid printer, and 4-phase bipolar stepping motor.
Sprague Electric TP 72-4 (5 pg.)

7 **"Programmable Trigger Circuit for Triac Phase Control"**
The circuit uses an operational amplifier and external components. Provides notes on operation and a circuit description. Applications: motor control, temperature control, switching rate control, and frequency controlled lighting.
Texas Instruments Application Report CA-137 (7 pg.)

Power Supplies

8 **"+5 To −15 Volts DC Converter"**
(LM311)
Describes use of the LM311 comparator for this voltage conversion.
National Linear Applications LB-18 (2 pg.)

9 **"Switched Mode Power Supplies—Highlighting a 5-V, 40-A Inverter Design"**
Discusses advantages of various approaches to regulator circuits. Describes in detail an 80% efficient 5v, 40a inverter which includes CMOS logic and an opto-electronic coupler.
Motorola AN-737 (16 pg.)

Power Transistor ICs

10 **"Fast IC Power Transistor with Thermal Protection"**
(LM195)
Circuit design of the LM195 IC power transistor, a three terminal device with safe area protection plus current and thermal limiting. Applications: 6 amp variable output switching regulator, 1 amp positive and negative voltage regulators, time delay circuit, and optically controlled switch, power amplifier and voltage follower.
National AN-110 (6 pg.)

Preamplifiers

11 **"Applications of the μA739 and μA749 Dual Preamplifier Integrated Circuits In Home Entertainment Equipment"**
See listing under Consumer, Audio. (Fairchild)

12 **"Audio Handbook"**
See listing under Consumer, Audio (National)

13 **"IC Preamp Challenges Choppers On Drift"**
(LM108A, LM121)
Describes circuit of the LM121 preamplifier and discusses offset balancing, achieving of low drift, and typical operating performance. Also covers effects of the associated operational amplifier citing the LM108A as an example.
National AN-79 (8 pg.)

14 **"Versatile IC Preamp Makes Thermocouple Amplifier With Cold Junction Compensation"**
(LM321, LM308A)
Discusses use of LM321 preamp with LM308A operational amplifier to form a precision, low-drift operational amplifier that also acts as a cold junction compensator.
National Linear Brief-24 (2 pg.)

15 **"LM381 Low Noise Dual Preamplifier"**
(LM381)
Describes the circuit. Discusses application as various tape amplifiers, phono preamplifier, and an audio mixer.
National Linear Applications AN-64 (12 pg.)

16 **"LM381A Dual Preamplifier for Ultra-Low Noise Applications"**
(LM381)
Gives detailed description of circuit operation of LM381A.
National Linear Applications AN-70 (4 pg.)

Regulators

17 **"More Voltage Regulator Applications Using the μA723"**
(μA723)
Describes foldback current limiting in positive and negative regulators, negative shunt regulation, and other techniques applicable to use of this device.
Fairchild Application Note 276 (4 pg.)

18 **"The μA7800 Series, Three Terminal Positive Voltage Regulators"**
(μA7800)
Discusses the circuit and operation of this 3-lead, 15-watt regulator series. Discusses variable output voltage, high output current negative voltage regulation and use as an audio amplifier.
Fairchild Application Note 312 (6 pg.)

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Regulators (cont)

1 **"The Voltage Regulator Applications Handbook"**

(μA104, μA105, μA109, μA723, μA7600, μA7800, μA78L00, μA78M00, μA79E00)

Gives specifications and parameters for various IC regulators and includes a selection guide. It devotes two chapters to each major regulator family, the first chapter describes design and electrical characteristics, the second discusses electrical and thermal considerations which are useful as application guidelines.

Includes appendices covering switching regulator and power supply design and a guide to the selection and operation of suitable power transistors. Applications of 7800 and 78M00 include fixed output, current and dual polarity regulators.

The 79E00 applications include use as a high current negative voltage regulator. The 723 is discussed in 150 mA maximum, positive shunt regulators with high line rejection or high input voltage, floating positive regulators, medium/high output current negative regulators, and several other applications.

The 104, 105, and 109 applications include high current, switching and floating regulators.

Fairchild Voltage Regulator Applications Handbook (96 pg.)

2 **"Designing Digitally-Controlled Power Supplies"**

((MC1406, MC1408, MC1466, MC1723)

Discusses two approaches to designing power supplies, one using the MC1723 voltage regulator, the other using the MC1466 floating regulator with optoelectronic isolation. Also discusses BCD-to-binary converter and memory options.

Motorola AN-703 (8 pg.)

3 **"A New Approach to Switching Regulators"**

Describes a 24 volt 3 ampere switching mode supply which operates at 20 kHz from a 120 volt AC line with 70% efficiency. Briefly discusses load-line shaping to reduce power losses and to reduce noise.

Motorola AN-719 (11 pg.)

4 **"LM340 Series Three Terminal Positive Regulators"**

(LM340)

Describes this 1 ampere regulator circuit. Applications: constant current source, high current regulator with short circuit current limit, 5 v regulator for TTL, adjustable output voltage regulators, tracking dual regulator, and high voltage regulators.

National AN-103 (12 pg.)

5 **"Designs for Negative Voltage Regulators"**

(LM104, LM204, LM304)

Describes the LM104 and covers pitfalls that cause unexpected failures as well as protection schemes. Includes discussions of high current regulators, symmetrical power supplies, high voltage regulators, switching and high current switching regulators, and driven switching regulators.

National Linear Applications AN-21 (16 pg.)

6 **"The LM105—An Improved Positive Regulator"**

(LM105, LM205, LM305)

Describes the circuit of this regulator, power limitations, using booster transistors, foldback current limiting, and dominant failure mechanisms.

National Linear Applications AN-23 (8 pg.)

7 **"IC Provides On-Card Regulation for Logic Circuits"**

(LM109)

Discusses design of regulators in general and describes the LM109. Covers application as a fixed 5V regulator, adjustable-output regulator, current regulator and high stability regulator.

National Linear Applications AN-42 (6 pg.)

8 **"1.2 Volt Reference"**

(LM113)

Describes the LM113 temperature compensated shunt regulator diode. Applications: low voltage regulator circuits, bias current source for a differential amplifier, and an electronic thermometer circuit.

National Linear Applications AN-56 (4 pg.)

9 **"Worst Case Power Dissipation in Linear Regulators"**

(LM100, LM104, LM200, LM204, LM300, LM304)

Discusses problems of excessive dissipation in regulators and suggests solutions using LM100 and LM104.

National Linear Applications LB-3 (2 pg.)

Regulators (cont)

10 **"Tracking Voltage Regulators"**

(LM104, LM105, LM204, LM205, LM304, LM305)

Describes adjusting several regulator voltages with one potentiometer, tracking positive and negative regulators using the LM104 as an amplifier, and tracking regulators with different output voltages.

National Linear Applications LB-7 (2 pg.)

11 **"IC Regulators Simplify Power Supply Design"**

(LM104, LM105, LM204, LM205, LM304, LM305)

Describes use of LM104 and LM105, in 0.2 and 2A regulator circuits. Provides circuit construction hints.

National Linear Applications LB-10 (2 pg.)

12 **"High Stability Regulators"**

(LM108A, LM109, LM208A, LM209, LM308A, LM309)

Describes design and gives schematics for high stability positive and negative regulators using LM109 and LM108A.

National Linear Applications LB-15 (2 pg.)

13 **"New Uses for the LM100 Regulator"**

(LM100)

Applications include shunt regulator, switching regulator with overload shutoff, temperature controller, power amplifier, SSB transmitter, light-intensity regulator, and photomultiplier tube supply.

National Linear Applications Handbook, AN-8 (12 pg.)

14 **"A Versatile, Monolithic Voltage Regulator"**

(LM100)

Circuit operation. Applications for the LM100 between 2 v to 30 v (up to 2 amps with two external transistors) are discusses. Includes high power, switchback current limiting, negative voltage, temperature compensating, and switching regulators.

National Linear Applications Handbook, AN-1 (11 pg.)

15 **"Designing Switching Regulators"**

(LM100)

LM100 applications discussed include high current, driven switching, current limiting, negative and high voltage regulators, as well as switching, and linear regulator combinations.

National Linear Applications Handbook, AN-2 (12 pg.)

16 **"LM125/LM126/LM127 Precision Dual Tracking Regulators"**

(LM125, LM126, LM127)

Circuit description, operation and applications, including current boosting, are discussed along with charts depicting external current limiting characteristics and a discussion of foldback current limiting. Electronic turn-off of the output without removing the input voltage is also described.

National Applications Report AN82 (15 pg.)

17 **"Constant Current LED"**

(NSL4944)

Describes how this two lead LED/IC device can be used not only as an indicator but also as a rectifier and constant current source.

National AN-151 (4 pg.)

18 **"The 4195 Regulator"**

(RC4195, RM4195)

Describes application as a ± 15 v, 100 ma regulator; a ± 2.5 a regulator; a ± 15 to ± 50 v unit, or a complementary ± 3 to ± 27 v device.

Raytheon Semiconductor Application Note (9 pg.)

19 **"Applications of the CA3085 Series Monolithic IC Voltage Regulators"**

(CA3085)

Circuit description of positive regulators with output currents up to 100 milliamperes from −55°C to +125°C.

Applications include high-current and constant-current regulators; switching, dual-tracking and high-voltage regulators. Use as a general purpose amplifier, and various methods of current limiting are mentioned.

RCA ICAN-6157 (11 pg.)

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Regulators (cont)

1 **"723/823 Voltage Regulators"**
(723, 823)
Discusses characteristic device parameters, bias limitations, improvement of ripple rejection, external voltage sensing, thermal effects, protection, limiting and increasing the output current. Applications: switching regulator, tracking regulator, current sinking power supplies, precision current source, light intensity control, phase shift oscillator.
Teledyne Semiconductor Linear Application Note 2 (17 pg.)

2 **"The TL497 Switching Voltage Regulator"**
(TL497)
Covers principals of operation and use as a step-down, step-up or inverting regulator.
Texas Instruments Application Report (26 pg.)

Switches

3 **"Applications of the μA742 TRIGAC—A Zero Crossing AC Trigger"**
(μA742)
Describes this TRIGAC circuit. Includes a discussion of the transfer characteristics and performance plus operation from ac and dc supplies. Applications: 110 V ac single threshold control; single phase, 110 V ac dual threshold control with hysteresis; 110 V ac dual threshold control with time proportioning; with time proportioning for Y or Δ loads; operating with transformer isolation between control circuit and ac line; output pulse amplifier with transformer; output pulse inverter; period extender for time proportioning; initial cycle delay; sensor failure detection circuit; time delay "relay" circuit; 208 V ac dual threshold control 110 V ac, 400 Hz dual threshold control with single TRIGAC for Y loads.
Also includes a section listing parts and component location diagrams for these applications and discusses operation with a fixed dc supply. Covers use of the TRIGAC with nonresistive loads, discusses thyristor cells, and full wave output power switches for use with the device.
Fairchild (30 pg.)

4 **"The IH5009 Series of Low Cost Analog Switches"**
(IH5009 Series)
Describes circuit parameters, logic compatibility, and virtual ground switching applications including 4-channel multiplexer, gain ranging circuit, gain programmable amplifier and 16-channel multiplexer.
Intersil Application Bulletin A0004 (8 pg.)

5 **"A New CMOS Analog Gate Technology"**
General discussion of "latch up". Describes "floating body" process, which eliminates this problem.
Intersil Application Note A006 (2 pg.)

6 **"Understanding and Applying the Analog Switch"**
(IH5001, IH5009, IH5025, IH5040)
Compares parameters of analog switches. Applications of several switch families are discussed, including 3-channel differential multiplexer, gain programmable amplifier, gain ranging circuit, sample and hold circuit.
Intersil Application Bulletin A003 (16 pg.)

7 **"The MISER—A Monolithic Integrated Stored Energy Regulator"**
(LP1000)
Describes the operation of this 3 terminal, low voltage, threshold detector and switch. Emphasizes capacitor charging circuits with slow charge, rapid discharge characteristics. Applications: LED flasher, tone generator, relaxation oscillator.
Lithic Systems Application Note LAN-101 (3 pg.)

8 **"Application of the MC3416 Crosspoint Switch"**
(MC3416)
Describes operation and use of this 4 × 4 balanced crosspoint switch in telephone applications including PABX. Appendices cover dielectric isolation, SCR action and testing.
Motorola AN-760 (15 pg.)

Switches (cont)

9 **"High-Speed MOS Commutators"**
(MM451, MM453, MM454)
Discusses the lowered threshold voltages in commutators, on and off resistances, switching speed, noise and high-frequency noise control.
National Linear Applications AN-28 (8 pg.)

10 **"Applications of MOS Analog Switches"**
(LH0014, LH0019)
Discusses basic commutation circuits and describes the use of the LH0014 and LH0019 in linear amplifier applications, including reset functions and chopper circuits. Covers use of MOS switches as suppressed carrier double-sideband modulators and double-sideband demodulators. Also describes a circuit for a phase-locked loop AM-FM detector without tuned circuits.
National Linear Applications, also Interface Handbook AN-38 (8 pg.)

11 **"Analog-Signal Commutation"**
(MM450, MM451, MM454, MM550, MM551, MM552)
Describes dc characteristics involved in MOS IC switching of analog signals when the signal input range varies between ± 10 v.
National Linear Applications and also Interface Handbooks, AN-33 (6 pg.)

12 **"High Speed Analog Switches"**
(AM1000, AM1001, AM1002)
Discusses time domain multiplexing, current mode multiplexing, the switching characteristics of the AM1000 J-FET switches, and drive circuits.
National Interface Handbook, AN-53 (6 pg.)

13 **"PIN Diode Drivers"**
(DH0035, DH0035C)
Describes PIN diode switching requirements and application of DH0035 as a driver. Includes discussion of anode ground and cathode ground designs and of repetition rate considerations.
National Linear Applications, also Interface Handbook AN-49 (6 pg.)

14 **"Applications of the RCA-CA3062 IC Photo-Detector and Power Amplifier in Switching Circuits"**
(CA3062)
Describes circuit operation and application in a latched memory circuit, a light activated triac control, a triac control with automatic shut off and alarm, and a triac intrusion alarm system.
RCA ICAN-6538 (6 pg.)

15 **"Features and Applications of RCA IC Zero-Voltage Switches"**
(CA3058, CA3059, CA3079)
Discusses zero-voltage switch operation in general. Operation primarily with thyristors in ac power control and switching applications, including electric heating, oven/broiler control, machine control, light control and industrial systems.
RCA ICAN-6182 (28 pg.)

16 **"Some Applications of a Programmable Power Switch/Amplifier"**
See listing under Power Control. (RCA)

17 **"CMOS Analog Switches—A Powerful Design Tool"**
Describes CMOS switch construction, characteristics and operating precautions. Applications include: a four channel switch to multiplex a scope input, alow pass filter with digitally controlled frequency response, an amplifier with programmable inputs and gain, a sample and hold circuit, a latching switch, high frequency switching and multiplexer systems.
Siliconix Application Note AN75-1 (16 pg.)

18 **"Switching High-Frequency Signals with FET Integrated Circuits"**
(DG133, DG171, DG181, DG200)
Discussion of DG133/171/181/200 as rf switches. Gives equivalent circuits, "Off" isolation and "On" performance data. Applications: control of video monitor and switching between two video cameras.
Siliconix Application Note AN73-3 (16 pg.)

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Switches (cont)

1 **"Driver Circuits for the JFET Analog Switch"**
Discussion and comparison of resistor-coupled diode charge transfer, space transistor charge transfer, and switched resistor driver circuits for JFET switches.
Siliconix Application Note AN73-5 (12 pg.)

2 **"FETs as Analog Switches"**
General discussion of FET operation; detailed discussion of factors affecting switch performance, including specific load problems and applicable driver circuits.
Siliconix Application Note AN72-2 (12 pg.)

3 **"Analog Switches in Sample and Hold Circuits"**
Covers the effects of FET analog switch current handling capability on settling time and the effects of offset characteristics on sample and hold system accuracy. Describes inverting and non-inverting sample and hold circuits.
Siliconix Application Note AN74-2 (4 pg.)

4 **"Designing with Monolithic FET Switches"**
Describes MOSFET and JFET switch operation, plus driver considerations.
Siliconix Technical Article TA73-2 (4 pg.)

5 **"DG300 Series Analog Switch Applications"**
(DG300, DG301, DG302, DG303, DG304, DG305 DG306, DG307)
Describes device parameters and use in sample and hold, amplifier amps and multiplexer circuits.
Siliconix AN76-6 (11 pg.)

6 **"Magnetically-Activated Monolithic Integrated Circuits for Analog and Digital Applications"**
(ULN-3006)
Discusses the Hall effect, digital sensing and experiments in linear sensing.
Sprague Electric TP 71-11 (10 pg.)

7 **"In IC Form Hall Effect Devices Can Take on Many New Applications"**
(ULN3006)
Describes the Hall effect, suggests linear and digital applications.
Sprague Electric TP 71-12 (5 pg.)

8 **"Modes of Actuation for Type ULN-3006 'Hall Effect' Switches"**
(ULN-3006)
Describes magnetic operation of this non-contact, switching device.
Sprague Electric Application Note 27404.1 (4 pg.)

9 **"Suggested Output Loads for Type ULN-3006 'Hall Effect' Switches"**
(ULN-3006)
Diagrams connections to use the open collector output to drive transistors, thyristors, TTL and MOS circuits.
Sprague Electric Application Note 27404.2 (2 pg.)

Thermal Considerations

10 **"Thermal Evaluation of Integrated Circuits"**
Describes four methods for thermal evaluation, including reverse biasing substrate diodes.
Fairchild Application Note 205 (8 pg.)

11 **"Transient Thermal Resistance—General Data and Its Use"**
Discusses transient thermal resistance and its use and describes methods using various degrees of approximations to determine the junction temperature rise of a device. Also covers the concept of a duty cycle family of curves to simplify calculation of junction temperature rise under a repetitive pulse train.
Motorola AN-569 (15 pg.)

Thermal Considerations (cont)

12 **"Mounting Techniques For Metal Packaged Power Semiconductors"**
Discusses preparation of mounting surfaces, using thermal compounds, and fastening techniques. Gives typical interface thermal resistance for a number of packages.
Motorola AN-599 (5 pg.)

13 **"Mounting Procedure For, And Thermal Aspects Of, Thermopad Plastic Power Devices"**
Covers various methods of mounting and heat-sinking Motorola case number 77, 90, and 199 plastic power devices. Also discusses thermal resistance considerations, lead forming, and circuit board cleaning.
Motorola AN-290B (9 pg.)

14 **"Micropower Thermometer"**
See listing under Transducers. (National)

15 **"Thermal Resistance of Integrated Circuit Packages"**
Describes method of measuring package thermal resistance while package is immersed in constant-temperature, circulating oil bath that acts as an infinite heat sink.
Sprague Electric TP 72-7 (5 pg.)

16 **"Thermal Design for Plastic Integrated Circuits"**
(ULN-2277)
Discussion of chip power dissipation—using amplifier as an example—heat dissipation, ULN-2277 dual 2-watt audio power heat sinks, heat sink finishes, and forced air cooling.
Sprague Electric TP 74-1 (7 pg.)

17 **"New Heat Sinking Techniques for Hermetic DIPs"**
Describes use of stamped and extruded heat sinks and method of reversing IC die and bonding chip directly to Kovar base.
Sprague Electric TP 74-4 (4 pg.)

Timers

18 **"Single-Chip Frequency Synthesizer Employing the XR2240"**
(XR2240)
Describes use of this timer/counter as a single-chip frequency synthesizer: $f_o = f_r (m/n+1)$ Where f_o < 200kHz. Describes generating 100 Hz synchronized to 60 Hz line.
Exar TB-1003 (3 pg.)

19 **"Versatile Timer Operates From Microseconds to Hours"**
(LM122)
Describes the LM122 circuit and its operation. Includes discussion of pin functions, timing errors and noisy environments. Discusses use as various timers, as a pulse width detector, a comparator, an oscillator, a two-terminal time delay switch, and a frequency to voltage converter.
National AN-97 (12 pg.)

20 **"1.3 volt IC Flasher, Oscillator Trigger, or Alarm"**
(LM3903)
Describes circuit operation. Covers various flasher, tone generator and trigger circuits, especially for low voltage applications in anything from toys to laboratory equipment.
National AN-154 (10 pg.)

21 **"Problem Solving with the Dual Set Point Timer"**
(DF215)
Describes the device and its use as various timers and controls.
Siliconix AN76-2 (10 pg.)

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Transducers

1 **"Micropower Thermometer"**
(LX5600)
Describes use of the LX5600 as a thermometer whose output is a current proportional to temperature and can drive a meter for direct readout.
National Linear Brief-27 or Transducer Handbook TB-11 (2 pg.)

2 **"Pressure Transducers as Accelerometers"**
(LX1700G)
Discusses uses of accelerometers and describes scheme of converting LX series pressure transducers to cover ranges from fractions to thousands of g's.
National Transducer Handbook AN-96 (4 pg.)

3 **"LX Series Pressure Transducers: Design and Applications Information"**
(LX1600A, LX1601A, LX1602A)
Describes hybrid transducer circuit and applications, including pressure to frequency converter, latching altitude detector, digital readout barometer and altimeter.
National AN-94 (8 pg.)

4 **"Pressure Transducer Load Cell"**
(LX1700G)
Describes use of LX1700G pressure transducer to measure weight.
National Transducer Handbook AN-95 (4 pg.)

5 **"The LX1602A Pressure Transducer and Altimeter Applications"**
(LX1602A)
Describes how to use this transducer along with additional electronics to build an altimeter that operates over a range of −1,000 feet to +50,000 feet.
National AN-91 (3 pg.)

6 **"Transducers in Fluid Flow Applications"**
(LX1602A)
Discusses application of LX1602A in pressure vessel, open flow and closed flow applications.
National Transducer Handbook AN-93 (8 pg.)

7 **"Transducer Sensor Diaphram 15 Million Cycle Life Test"**
Findings in the continuing test of National's transducer sensing elements—a silicon membrane approx. 1 mil thick.
National Transducer Brief 3 (1 pg.)

8 **"Use of the SK1007 Pressure Transducer Kit in Vault Alarm Systems"**
Describes application of this multi-level switch kit with a pressure transducer in vault alarm systems.
National Transducer Brief 7 (2 pg.)

9 **"The Multi-Level Switch Kit, Part No. SK1007"**
Details the use of any LX series pressure transducer to produce a high level analog output as well as three independent switch points.
National Transducer Handbook TB-1 (2 pgs.)

10 **"Transducer Fluid Filled Option"**
Describes the "Fluid-Filled" methods of protecting transducers from hostile environments. Rates the resistance of silicone rubber to some common fluids.
National Transducer Brief 8 (2 pg.)

11 **"Installation Ideas for Pressure Transducers"**
(LX1600, LX1700, LX1400, LX1701, LX3700)
Provides suggestions for mounting National transducers for various applications. Includes diagrams and typical mounting configurations.
National Transducer Handbook AN-92 (4 pg.)

Transducers (cont)

12 **"Zeroing Transducer Output Voltage"**
(LX1600 Series)
Shows how to set the supply voltages to provide an output starting at 0v.
National Transducer Handbook TB-5 (2 pg.)

13 **"Externally Zeroing Transducer Output Voltage"**
(LX1603G, LX1604G)
Describes how to use external components to zero the transducer output voltage. Tables compare output of the LX1603G and LX1604 devices.
National Transducer Handbook TB-5 (2 pg.)

14 **"Automatic Zeroing Circuit"**
Diagrams an auto-zeroing system and describes its operation. Lists specifications and sensitivity.
National Transducer Handbook TB-4 (2 pg.)

15 **"Pressure to Current Converter (3 Wire)"**
(LX Series)
Describes the use of any LX series pressure transducer to obtain a pressure to current translator.
National Transducer Handbook TB-4 (2 pg.)

16 **"Current Sourcing and Sinking"**
(LX Series)
Offers a method that utilizes any LX()02() 0 to 15 psi transducer that sinks a standard 4 to 20 mA output (1:5 range) for a 3 to 15 psi pressure input (ratio 1:5 range)
National Transducer Handbook TB-15 (1 pg.)

17 **"Pressure to Frequency Converter"**
Shows how to take advantage of the hybrid construction of a pressure transducer and how to construct a self-contained voltage controlled oscillator.
National Transducer Handbook TB-13 (1 pg.)

18 **"Flow Velocity Measurement by Analog Shaping"**
(LX Series)
Discusses using an LX series pressure transducer to determine a fluid's flow velocity by extracting the square root of the transducer's analog voltage output.
National Transducer Handbook TB-20 (1 pg.)

19 **"Latching Altitude Detector"**
(LX1602A)
Uses the LX1602A absolute pressure transducer to construct an altitude detector that latches on when given pressure is exceeded.
National Transducer Handbook TB-21 (2 pg.)

20 **"Solid State Barometers"**
(LX3700 Series)
Describes how to use thermostatically controlled pressure transducers as barometers with readout in inches of mercury. TORR or millibars.
National Transducer Handbook TB-18 (2 pg.)

21 **"Thermometer Using Pressure Transducers"**
(LX3700 Series)
Describes how to use a pressure transducer, to construct a constant volume gas, or "hot bulb", thermometer as an alternative to conventional electronic thermometers.
National Transducer Handbook TB-18 (2 pg.)

22 **"Acoustic Applications of Pressure Transducers"**
(LX Series)
Describes use of an LX series transducer as a microphone and sound pressure level meter, and the advantages over ordinary cardiod types.
National Transducer Handbook TB-19 (2 pg.)

23 **"Pressurized-Cable Fault Detection and Location"**
(LX1603A)
Describes the use of transducers in pressurized-cable control systems as early warning and break location alarms.
National Transducer Handbook AN-121 (3 pg.)

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Transducers (cont)

1 **"Medical Applications"**

Describes the use of Pressure Transducers for protecting electronic equipment and operators; constructing blook pressure monitoring systems, respirators, kidney dialysis machines and other medical related applications.

National Transducer Handbook AN-122 (3 pg.)

2 **"Automotive Applications"**

Describes the use of pressure transducers in automotive electronics for fuel metering, ignition management and other applications.

National Transducer Handbook AN-120 (4 pg.)

3 **"Calibrating the LX5600"**

(LX5600)

Discusses the accuracy of the LX5600 temperature transducer as well as three types of error—offset, slope and linearity.

National Transducer Handbook TB-9 (1 pg.)

4 **"IC Transducers Simplify Temperature Control Circuits"**

(LX5600)

Describes the advantages of this temperature transducer device in on/off temperature control applications. Also discusses construction of a temperature controller.

National Transducer Handbook TB-10 (3 pg.)

5 **"A New Interfacing Concept; The Monolithic Temperature Transducer"**

(LX5600, LX5700)

Covers alternate methods of powering the LX5600, load isolation and an unusual active thermal shield (the shield tracks the surface temperature of the sensor.) Describes use as a thermal transducer, temperature to frequency converter, and a temperature controller with rate-of-change sensing. Discusses use of differential temperature measurements for liquid or moving air detection (including wind) and for position sensing (using a heat source as a position reference.)

National AN-132 (10 pg.)

6 **"Manual Control With Load Cells"**

Advocates the use of pressure transducers in force actuated controls for a better man-machine interface.

National Transducer Handbook TB-16 (1 pg.)

7 **"Thermometer Application of the REF-02"**

(REF-02)

Discusses thermometer essentials, bandgap voltage reference theory, and basic circuit design using device.

Precision Monolithics AN-18 (4 pg.)

MEMORY

Analog

8 **"Delaying AF Signals with MOS Delay-Lines TCA 350"**

(TCA350)

Discusses bucket brigade circuits and practical applications employing this device.

ITT Semiconductors (7 pg.)

9 **"Principles of Analog Discrete-Time Signal Processing Devices"**

(SAD, SAM, SAP, TAD)

Describes a family of devices that effectively sample and store analog signals, quantizing time but retaining analog signal values. Different readout sequences result in processing the stored signals. Covers use as fixed and variable time delay, filters, correlation, convolution, time base modification, and video time base correction.

Reticon Application Note 102 (17 pg.)

10 **"Applications of Reticon TAD-12 Tapped Analog Delay"**

(TAD-12)

Describes the use of this clock controlled analog delay line in low pass and bandpass filter applications. Includes mathematical discussion of second order filter design. Briefly covers correlation and pattern recornition.

Reticon Application Note 103 (9 pg.)

11 **"Acoustic Applications of Serial Analog Delay Devices"**

(SAD-1024)

Covers use in reverberation, vibrato, chorus, wow and flutter control plus considerations in using this device.

Reticon Application Note 104 (8 pg.)

12 **"Bucket Brigade Devices Circa 1976"**

Gives history of development, construction features, and advantages of bucket brigade devices.

Reticon Technical Note No. 107 (11 pg.)

13 **"A Tapped Analog Delay for Sampled Data Signal Processing"**

Introduces tapped analog delays and gives various applications heretofore accomplished by digital techniques.

Reticon Application Note No. 105 (11 pg.)

14 **"Serial Operation of Clocked Analog Delay Lines to Obtain Long Delay"**

(SAD-1024)

Describes advantages, coupling, and performance of device. Reticon Application Note No. 109 (8 pg.)

15 **"Implementation of Discrete-Time Analog Filter and Processing Systems"**

(TAD-32)

Discusses tapped analog delay device operation and areas of application, including transversal and recursive filters.

Reticon Application Note No. 111 (10 pg.)

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MEMORY

CAMs

1 **"Designing with the SCM5533 CMOS Content Addressable Memory"**
(SCM5533)
Describes operation, matching, expansion, multifield association, pattern recognition, learning and a target acquisition system.
Solid State Scientific AN-110 (14 pg.)

Character Generators

2 **"A CRT Display System Using NMOS Memories"**
(MC6545, MCM6570, MCM6571)
Discusses basic crt operation, character formation and describes the 8K-bit MCM6570 character generators. Describes a 128-character system in detail, including counter and retrace control, memory select, and address register sections.
Motorola AN-706A (15 pg.)

3 **"American and European Fonts In Standard Character Generators"**
(MM4240, MM5240, MM4241, MM5241)
Depicts the standard 64 character subsets for these devices.
National MOS Handbook AN-57 (6 pg.)

4 **"The Systems Approach to Character Generators"**
See listing under ROMs. (National)

5 **"Digital Display Generators"**
Using TTL compatible MOS ROMs to generate displays. Gives circuit diagrams and a sample readout.
National MOS Brief 8 (2 pg.)

6 **"7 × 9 Display Character Generator"**
Uses three MOS ROMs and some TTL logic to create a font of 64 7 × 9 dot-type characters. A circuit diagram and a suggested character forms are provided.
National MOS Brief 13 (2 pg.)

Interface

7 **"Operation of AM0026 at Short Pulse Widths"**
(0026)
Describes methods for obtaining pulse widths as low as 55 ns from this MOS clock driver.
Advanced Micro Devices Application Brief (8 pg.)

8 **"The Recovery of Recorded Digital Information in Drum, Disk and Tape Systems"**
Reviews methods for converting the analog signal obtained from a magnetic recording into digital format.
Motorola AN-711 (10 pg.)

9 **"Applying Modern Clock Drivers to MOS Memories"**
(DS0025, DS0026)
Covers use of 0025/26 drivers in MOS memory systems. Information includes selection of packages and heat sinks, power dissipation, rise and fall time, power supply decoupling, system clock line ringing and crosstalk, input coupling techniques, and sample calculations.
National MOS Handbook AN-76 (12 pg.)

Interface (cont)

10 **"Interfacing Circuits for MOS Dynamic Random Access Memories"**
Discusses interfacing methods employing level shifters (TTL to MOS levels) with boosters, level shifters (MOS to TTL levels), and sense amplifiers.
Nortec Applications Note No. 25 Rev. A (3 pg.)

11 **"Charge Pump Driver for 7001 RAMs"**
(SN5450B)
Defines a method for driving the charge storage pump input of a 7001 RAM. Provides a description of the basic storage pump RAM cell and the charge pump circuit diagram.
Gives performance curves.
Texas Instruments Application Report CA-178 (6 pg.)

12 **"High Speed TTL Interfacing for 7001 Static RAMs"**
(SN75261, SN75365)
Illustrates interface techniques for driving the 7001 RAM chip-select input, and sensing the memory output.
Texas Instruments Application Report CA-179 (8 pg.)

Microprogramming

13 **"Tri-State Logic in High-Speed Memories of Microprogrammed Computers"**
See listing under (Digital) TTL, General. (National)

PROMs

14 **"Programmable Read Only Memories"**
(93417, 93427, 93436, 93438, 93448, 93452, 93453)
Gives general background on PROMs, describes programming procedures, discusses power switching, address expansion, 8-bit binary to decimal decoding and programmed logic controller.
Fairchild Application Note 333 (16 pg.)

15 **"HPROM-0512 Bipolar PROM"**
(HPROM0512)
Covers basic programming considerations, automatic and custom programming of this 64-word by 8-bit memory.
Harris Application Note 202 (8 pg.)

16 **"Programming the HPROM-0512 In An Expanded Configuration"**
(HPROM0512)
Describes normal and expanded bit/word programming with sample calculations for a 256-word system. Describes programming expanded ROMs installed in a logic system.
Harris Application Note 203 (4 pg.)

17 **"Application of the Intel 2708 8K Erasable PROM"**
(2708)
Covers characteristics, operation, programming and erasure, reduced power and interface.
Intel Application Note AP-17 (15 pg.)

18 **"Polysilicon Fuse Bipolar PROMs"**
(3601, 3602, 3604, 3621, 3622, 3624)
Description of devices, testing methods and results, are presented.
Intel RR-8 (7 pg.)

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MEMORY

PROMs (cont)

1 **"Programming the MCM5003/5004 Programmable Read Only Memory"**
(MCM5003, MCM5004)
Discusses programming methods for this 64 × 8 bit memory, describes circuit and operation. Describes a simple programmer using five ICs and a more sophisticaled version using 25 ICs offering automatic sequencing.
Motorola AN-550 (12 pg.)

RAMs

2 **"Application of First-In First-Out Memories"**
(Am2812, Am2813, Am2814, 3341)
Describes the function of a first-in, first-out memory, methods of constructing FIFO buffers and the operation of the above P-channel MOS devices. Discusses storage and control, expansion methods, interfacing, and applications in an N-bit shift register and as a key encoder on key metrix.
Advanced Micro Devices Application Note (9 pg.)

3 **"AM9130/AM9140, Designing With Self-Clocking, Adaptive 4K Static R/W Random Access Memories"**
(AM9130, AM9140)
Describes general characteristics, interface signals, internal circuitry, and systems design of AM9130/AM9140.
Advanced Micro Devices (15 pg.)

4 **"AMS7001 Basic Storage Module High Speed Memories"**
(AMS7001)
Discusses AMS7001 storage module operation, backplane wiring, addressing scheme, and power requirements.
Intersil (AMS) AN-35 (18 pg.)

5 **"Using the TM-200 Semiconductor Memory Card"**
(AMS7001)
Describes this memory card using the AMS7001 RAM. Includes detailed diagrams.
Intersil (AMS) AN-36 (22 pg.)

6 **"Layout Considerations Using 4K MOS RAMs"**
Discusses orientation, packing, drivers, power distribution, trace widths, signal levels, bypass caps, and bus bars.
Intersil (AMS) AN-37 (4 pg.)

7 **"The AM9338 Multiple Port Memory"**
(9338)
Describes applications for this 8-word by 1-bit three-address memory, including the working store for high-speed, three address computers; first in, first out (asynchronous buffer) memory; and direct address/indirect address memory.
Advanced Micro Devices Application Note (4 pg.)

8 **"Application of the EMM/SEMI 4200 Static RAM to the Intel 8080A Microprocessor"**
(4200)
Describes suggested logic interface to connect this 4K×1 static RAM to 8080A MPU.
EMM/Semi Application Note S103A)4 pg.)

9 **"Application of EMM/SEMI 4K Static RAM to Motorola M6800 Microprocessor"**
(4200)
Describes suggested logic interface to connect this 4K×1 static RAM to the M6800 MPU.
EMM/Semi Application Note S104 (6 pg.)

10 **"Checking Out the EMM/Semi 4200 in 2107B or 4060 Sockets"**
(4200)
Suggests circuit changes to permit acceptance of the 4200 static RAM in sockets wired for 2107B or 4060 Sockets"
EMM/Semi Application Note S102 (2 pg.)

RAMs (cont)

11 **"93400 TTL Random Access Memories For High-Speed Applications"**
(7481, 7489)
Summarizes the uses for the 7481/93403 (general purpose); 7489/93407, 93433, and 93435 (highest speed); and 93400 (lower-cost, medium-to high speed). Discusses application in memory systems.
Fairchild Application Note 219 (9 pg.)

12 **"TTL/MSI 9334 8-Bit Addressable Latch"**
(9334)
Describes operation and applications, including 16 and 32-bit addressable latches, 16-word by 4-bit memory, demultiplexer and decoder, 8-bit A/D converter and a 16-bit serial-to parallel converter.
Fairchild Application Note 220 (8 pg.)

13 **"Understanding the FIFO"**
(3351)
Covers 3351 FIFO operation, cascading, plus use in data rate buffering, parallel operation, and burst operation.
Fairchild APP 332 (8 pg.)

14 **"Intel Memory Design Handbook"**
Combines various RAM, ROM, PROM and CCD application notes listed separately, plus information on support circuits.
Intel $5.00 (265 pg.)

15 **"Designing Memory Systems With the Intel 2107A 4K RAM"**
(2107A)
Describes the application of this 4096×1 RAM. Includes driving, sensing and power considerations.
Intel Application Note AP4 (16 pg.)

16 **"Memory System Design with the Intel 2107B 4K RAM"**
(2107B, 3210, 3225)
Describes the operation and performance of the 2107B and memory systems considerations such as drivers, buffers, timing, layout, decoupling, debugging and power calculations.
Intel Application Note AP-10 (36 pg.)

17 **"2107A/2107B N-Channel Silicon Gate MOS 4K RAMs"**
(2107A, 2107B)
Describes operation of the devices, failure mechanisms, Intel's reliability program and test result' ARPPENDIX TNTS SOME RELIABILITY INFORMATION ON OTHER RAMs.
Intel Reliability Report RR-7 (20 pg.)

18 **"Designing Non-Volatile Memory Systems with Intel's 5101 RAM"**
(5101)
Describes internal circuits and operation of the RAM. Outlines circuit techniques for battery supported non-volatile operation. Describes use of the device with the MCS-40 microcomputer.
Intel Application Note AP-12 (28 pg.)

19 **"MOS Static RAMs"**
(2101, 2102, 2111, 2112, 5101)
Presents devices, failure mechanisms, testing methods and results.
Intel RR-9 (7 pg.)

20 **"2416 16K CCD Memory"**
(2416)
Describes device, failure modes, reliability tests and results.
Intel RR-11 (5 pg.)

21 **"CMOS RAMs"**
(IM6508, IM6523, IM6524)
Provides a block diagram and describes the operation and interface requirements for these 256×1 and 1024×1 CMOS RAMs.
Intersil Application Bulletin M002 (8 pg.)

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RAMs (cont)

1 **"12/16K Memory System for the MK5065 Microprocessor"**
See listing under Microprocessors Systems (Mostek)

2 **"Considerations for Designing a High Density, Low Power Memory System"**
(MK4200)
Describes a 16K×8 memory array using the MK4200 4K RAM and CMOS logic.
Mostek (3 pg.)

3 **"An In-Depth Look at Mostek's High Performance MK4027"**
(MK4027)
Describes operation of this 16-pin, 4K RAM.
Mostek (15 pg.)

4 **"MK4096 Application Information"**
(MK4096)
Describes the MK4096 operation, shows details necessary for system design, describes interface with PDP-11 processor.
Mostek (8 pg.)

5 **"The Design of an N-Channel 16K × 16 Bit Memory System for the PDP-11"**
(MCM6605, MC3450, MC3452, MC3459, MC3460)
Briefly describes operation of the MCM6605 NMOS RAM, the details the design of a PDP-11 add-on mainframe memory using this device. The interface ICs and system performance are also discussed.
Motorola AN-740 (15 pg.)

6 **"Semiconductor for Plated Wire Memories"**
See listing under (Digital) Interface. (Motorola)

7 **"A High Speed FIFO Memory Using the MECL MC10143 Register File"**
See listing under (Digital) High Speed Logic (Motorola)

8 **"A CMOS Keyboard Data Entry System for Bus Oriented memory Systems"**
(MC14419)
Describes a keypad to binary data entry system for placing data in RAM memories. It allows data to be entered through keystrokes, encoding 4-bits at a time.
Motorola Application Note AN-759 (4 pg.)

9 **"A Non-volatile Microprocessor Memory Using 4K N-channel MOS RAMs"**
(MCM6605, MC6800)
Describes the design of a 8192-byte non-volatile memory using the MCM6605 4K × 1 RAM and CMOS control logic to reduce the power requirement in the standby mode.
Motorola AN-732A (17 pg.)

10 **"Using Tri State™ Logic for Rubber Band Memories"**
Describes the construction and use of scratch/pad memories to store data at a rapid rate and then release it as required. They serve as buffers between systems operating at different clock rates.
National Applications Report AN68 (4 pg.)

11 **"MOS Scratch Pad/Content Addressable Memory System"**
Describes a 64-bit Scratch Pad/Content Addressable Memory using MOS devices. Includes circuit diagrams and discusses circuit operations.
National MOS Brief 11 (2 pg.)

12 **"A Method of Implementing Stacks With Existing Minicomputer Memory"**
Gives detailed description of a controller for a stack of programmable size up to 256 words for a 16-bit minicomputer with less than 16k of memory. Tells how stack size can be increased to 4096 words by adding ten ICs.
National AN-60 (4 pg.)

RAMs (cont)

13 **"Designing Memory Systems Using the MM5262"**
(MM4262, MM5262)
Provides a detailed description of this 2048×1 PMOS dynamic RAM, operating instructions, and a diagram of a 16K × 10 memory using the device.
National AN-144 (14 pg.)

14 **"A Simple Power Saving Technique for the MM5262 2k RAM"**
(MM5265)
Describes method for decoding the clocks of unselected chips in a memory array to save power. Discusses application in 8k × 16 memory.
National MOS Handbook AN-86 (4 pg.)

15 **"Memory Systems Built with the Nortec 6002"**
(6002)
Describes circuits for the bit driver/sense amplifier required to interface the 6002 with TTL. Discusses external support circuit parameters and internal circuit operations that affect system performance.
Nortec Applications Note No. 28 (4 pg.)

16 **"Memory Systems Built with the Nortec 6002"**
(6002)
Describes use of this 1024-bit RAM in building a general purpose memory module with 425,984 bit capacity.
Nortec Applications Note No. 30 (14 pg.)

17 **"Printed Circuit Layout Considerations for Dynamic Memory Arrays"**
Gives P.C. layout guidelines for MOS dynamic memories (also applicable to standard TTL circuits.)
Nortec Applications Note No. 31 (2 pg.)

18 **"Designing Memory Systems with the Nortec 6003 RAM"**
(6003)
Describes operation of this 2048-bit RAM, including a discussion of memory timing, refresh control, array control signals, device output sensing, and array driver circuits.
Nortec Applications Note No. 32 (9 pg.)

19 **"Applications Information for the RCA MW7001ID RAM"**
(MW7001)
Discusses operation of the RAM's charge pump, input loading and recommended interface circuits.
RCA ICAN-6401 (5 pg.)

20 **"Memory Systems Characteristics and Applications for the CD4061A"**
(CD4061A)
Describes basic device operation, application in memory systems, and testing including construction of an all CMOS memory tester.
RCA ICAN-6445

21 **"Driving the TMS4030 RAM using the SN75363 or SN75322"**
(SN75322, SN7536, TMS4030)
Driving the TMS4030 chip enable clock with these ICs, switching speeds versus system size, general performance characteristics and performance comparisons are provided.
Texas Instruments Application Report CA-181 (7 pg.)

22 **"The 4K RAM Dilemma; 16, 18 or 22 pin?"**
(TMS4050, TMS4060)
Discusses trade-offs in applying these RAM configurations.
Texas Instruments (20 pg.)

ROMs

23 **"Designing with Intel PROMs and ROMs"**
See listing under PROMs (Intel)

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MEMORY

ROMs (cont)

1 **"Monolithic Diode Matrices"**

Describes programming and use of diode matrices. Applications: teletypewriter coding matrix, decimal decode for displays, nines complement-BCD, shift register matrices, and ROMs.

Harris Application Note 206 (16 pg.)

2 **"MCS2026-002"**

(MCS2026-002)

Describes connections to use this demonstrator version of the 16K (2048×8) dynamic ROM, which can be used as an adder, counter, enocder, decoder or shift register.

MOS Technology Application Note MCS2026-002 (8 pg.)

3 **"Code Conversion With Semiconductor Read Only Memories"**

(MCM4000)

Describes methods for converting data from binary to BCD and vice versa, from the Hollerith to the common 8-bit codes, and from one 8-bit code to another.

Motorola AN-506 (13 pg.)

4 **"Replacing Sequential Logic with ROMs"**

Describes design methods for using ROMs to replace sequential logic, that is to replace designs that would require random or combinational logic with feedback loops.

Motorola AN-722 (19 pg.)

5 **"Saving ROMs in High-Resolution Dot-Matrix Displays and Printers"**

(MM5232, MM5240, MM5241, DM8596, MM8597)

Describes two-stage, column-generation approach called "intermediate coding" that saves more than 25% of ROM capacity when several ROMs are needed to store a font.

National MOS Handbook AN-85 (8 pg.)

6 **"The Application of ROMs"**

(MM5203, MM5230, MM5232, MM5240)

Describes applications of read only memories in table look up, code conversion and generation, character generation, random logic generation, and microprogramming.

National AN-61 (12 pg.)

7 **"Custom ROM Programming"**

Gives forms for submitting truth tables for various National read only memories.

National MOS Handbook AN-100 (8 pg.)

8 **"The Systems Approach to Character Generators"**

(MM5240, MM5241)

Discusses use of MM5240 and MM5241 ROMs in character generation. Includes discussion of CRT raster scan displays, refresh memory modulation, control logic, bipolar compatibility, printing applications, and raster scan systems.

National MOS Handbook AN-40 (12 pg.)

9 **"Trig Function Generators"**

Instead of simply cascading ROM to increase resolution and accuracy of the look-up tables, this notes describes interpolation techniques to increase trig function accuracy with less memory.

National MOS Handbook, MOS Brief 10 (2 pg.)

10 **"MOS Goes Bipolar"**

See listing under Shift Registers (National)

11 **"Fast Multipliers Using TTL Read Only Memories"**

(SN74182, SN74H183, SN74283, SN74284, SN74285)

Reviews fundamental algorithm of binary multiplication. Shows use of ROMs for multiplication, two's complement multiplication, and truncated multiplications.

Texas Instruments Application Report CA-172 (11 pg.)

Shift Registers

12 **"A Random Pattern Generator for Testing Digital Delay Elements"**

Describes the use of a linear feedback shift register for digital testing.

Advanced Micro Devices Application Note (3 pg.)

13 **"Applications of Dynamic Shift Registers"**

(1402A, 1403A, 1404A, 1405A, Am2802, Am2803, Am2804, Am2805, Am2806, Am2807, Am2808)

Discusses dynamic shift register storage in general, clock timing, circuits for clock drivers, interfacing with TTL, and recirculating registers.

Advanced Micro Devices Application Note (7 pg.)

14 **"Schottky TTL MSI Registers"**

(AM25S07, AM25S08, AM25S09, SN54S174, SN54S175, SN54S194, SN54S195, SN74S174, SN74S175, SN74S194, SN74S195)

Describes these 4 and 6-bit registers, their operation and applications. Contains logic diagrams and function tables. Applications covered include: longer words, use with dynamic shift registers, selective bus storage, use as a LIFO memory, psuedo random feedback, unique counting codes, permutation of inputs, and use in arithmetic.

Advanced Micro Devices Application Note (16 pg.)

15 **"High-speed Shift Registers Use TTL RAMs and Counters to do all the Shifting'**

Describes how to build a high speed shift register using a RAM accessed by counters.

Advanced Micro Devices (2 pg.)

16 **"The MSI 9328 Dual 8-Bit Shift Register"**

(9328)

Describes operation of this device and discusses applications, including variable-length shift registers, serial memories, counters.

Fairchild Application Note 182 (7 pg.)

17 **"9338 Eight-Bit Multiple Port Register"**

(9338)

Describes the features of this device, the TTL/MSI equivalent and parallel serial expansion capabilities. Covers use as three address arithmetic unit with eight registers, and use in a first-in first-out memory.

Fairchilf Application Note 294 (6 pg.)

18 **"Design and Application of Intel's 2416 16K Charge Coupled Device"**

19 **"Using Shift Registers as Pulse Delay Networks"**

See listing under (Digital) High Speed Logic (Motorola)

20 **"The MC7491A Eight-Bit Serial Shift Register and the MC7495 Four-Bit Shift Register"**

(MC5491A, MC5495, MC7491A, MC7495)

Describes operation of these devices and discusses application as shift counters, delay lines, buffers, serial-parallel converters, parallel-serial converters, ring counters, and parallel arithmetic units. Also describes use in a teletypewriter-computer interface system.

Motorola AN-530A (9 pg.)

21 **"The MC4012, AN MTTL 4-Bit Shift Register"**

(MC4012)

Discusses circuit operation and applications, including serial to parallel conversion, divide-by-N counting, programmable frequency division, and programmable burst generation.

Motorola AN-505 (11 pg.)

22 **"The Logical Design of Shift Counters"**

See listing under (Digital) Counters. (Motorola)

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Shift Registers (cont)

1 **"Programmable Divider Applications"**
(DM7520, DM8520)
Describes basic operation of DM7520/DM8520 divider. Covers optimum speed operation, programming, operating mode connections, applications as a speed controller for a two phase synchronous motor, and as a pseudo-random bit generator.
National AN-17 (8 pg.)

2 **"New MOS Clock Driver For MOS Shift Register"**
(MH0007)
Describes NH0007 circuit, turn-on characteristics, turn-off speed, power dissipation, and discusses application as a two-phase MOS clock system.
National AN-18 (8 pg.)

3 **"Low Power MOS Clock-Modulated Memory Systems"**
(MM400, MM402, MM406, MM451, MM482)
Presents several memory techniques to save power. Tabulates and compares methods for relative power utilization.
National AN-19 (7 pg.)

4 **"Design Considerations of MOS Dynamic Shift Registers With Tri-State Outputs"**
(MM4012, MM4013, MM5012, MM5013)
Describes operation of MOS shift registers with Tri-State push-pull outputs. Includes discussion of the dynamic characteristics and maximum clock frequency.
National AN-65 (4 pg.)

5 **"MOS Analog Function Generator"**
Describes the use of shift registers as delay lines. Shows methods to increase the clock rates and describes treating a long loop as several short ones to improve access.
National MOS Brief 4 (2 pg.)

6 **"MOS Delay Lines"**
(MM506)
Describes the characteristics of static and dynamic shift registers used in delay line. Discusses application as series/parallel delay lines and as substitutes for magnetic drum memories. Also covers specialized clocking techniques, such as two-speed clocking.
National AN-25 (8 pg.)

7 **"Low Frequency Operation With Dynamic Shift Registers"**
Discusses operation of two forms of dynamic shift registers: ratioless and ratio. Recommends techniques, such as keeping clock amplitudes high, to design added margin into systems. Discusses temperature considerations, packaging.
National MOS Handbook AN-55 (4 pg.)

8 **"Mask Programming Specializes MOS Shift Register Designs"**
(MM4007, MM4019, MM5007, MM5019)
Describes customizing MOS shift register bit lengths by programming a metalization mask used to manufacture these devices. Dual registers from 20 to 256 bits, and single registers from 40 to 512 bits are available. Describes single register tapped output options.
National MOS Handbook, MOS Brief 14 (2 pg.)

9 **"Double-Clocking Cuts Standard Registers to Non-Standard Sizes"**
Describes a method of double-clocking for N data input periods to make the register appear shortened by N bits. When this is achieved, the clock rate resumes normal frequency.
National MOS Handbook, MOS Brief 16 (2 pg.)

10 **"MOS Goes Bipolar"**
Shows what voltages are required to combine MOS Shift Registers and Read Only Memories with bipolar devices. Presents interface diagrams.
National MOS Brief 12 (2 pg.)

11 **"Static Shift Register Operating Curves"**
How to use the minimum/maximum clock pulse width operating curves included in National's static shift register data sheets.
National MOS Brief 15 (2 pg.)

Shift Registers (cont)

12 **"High Voltage Shift Registers Move Displays"**
(MM5081)
Describes use of the MM5081 high voltage shift register for driving gas discharge or lamp displays, ie. moving messages or moving graphics.
National AN-44 (14 pg.)

13 **"COS/MOS MSI Counter and Register Design and Applications"**
See listing under (Digital) CMOS (RCA)

14 **"HiNIL 375 Universal Shift Register"**
See listing under (Digital) HNIL/HTL (Teledyne Semiconductor))

MICROPROCESSORS

Applications

15 **"Using Mosteks F8 Microprocessor in a Scanned Seven-Segment Display Application"**
(F8)
Discusses the advantages of the F8 as a numeric display interface in μP based devices.
Mostek (16 pg.)

16 **"Using Mosteks F8 in a Scanned Keyboard Application"**
(F8)
Discusses application of the F8 to eliminate hardware outside the processor to encode the keyboard. Uses a keyboard scanning technique.
Mostek (16 pg.)

17 **"M6800 Microprocessor Application Manual"**
(M6800)
Describes the use of the 6800 family of parts. Gives details of practical applications including the development of hardware and software, design of a point of sale terminal and interfaces to peripherals.
Motorola $25.00 (716 pg.)

18 **"Data Handling with the IMP-8"**
(IMP-8, IMP-16)
Covers basic concepts for transferring data from a memory to peripherals.
National AN-117 (4 pg.)

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MICROPROCESSORS

Applications (cont)

1 **"Microprocessor Mates with MOS/LSI Keyboard Encoder"**
(IMP-16)
Shows how to interface a keyboard to the IMP-16 microprocessor for text editing.
National AN-128 (6 pg.)

2 **"The IMP-16 in Communication Applications**
(IMP-16)
Discusses communication processor functions, requirements for communications microprocessors and system considerations. Gives programming examples including status monitoring, data transmission, message routing, interrupt handling and error control.
National AN-134 (6 pg.)

3 **"Communication Interfaces for the IMP-16"**
(IMP-16)
Describes the use of this microprocessor in leased line and switched line applications with the communications conforming to EIA standard RS232-C.
National AN-152 (13 pg.)

4 **"The IMP-8C as a Data Concentrator"**
(IMP-8C)
Describes the use of this microprocessor in data concentrator applications. Covers use with a full duplex modem, and the terminal controller interface.
National AN-113 (6 pg.)

5 **"Multiple Microprocessors in Instrument Systems"**
(IMP-8, IMP-16)
Discusses systems built with central microcomputers plus peripheral microprocessors to distribute intelligence. Illustrates concepts with a data acquisition and setpoint control system.
National AN-106 (8 pg.)

6 **"PACE Logic Designers Guide to Programmed Equivalents to TTL Functions"**
(PACE)
Shows how standard TTL/MSI logic functions and subsystems are implemented in software for the PACE microprocessor.
National $5.00 (131 pg.)

7 **"How to Design with the Control Store Sequencer, 8X02"**
(8X02)
Presents a functional description and gives microprogramming suggestions.
Signetics AM-3 (6 pg.)

General

8 **"A Non-volatile Microprocessor Memory Using 4K N-channel MOS RAMs"**
See listing under (Memory) RAMs (Motorola)

9 **"Microprocessors - An Introduction"**
Shows system components, defines terms and describes operation of an elementary computer system.
National AN-114 (4 pg.)

10 **"Timesharing Users Manual"**
(IMP-8, IMP-16)
Gives user information to assemble IMP-8 or IMP-16 programs using Tymshare, Inc, services, or IMP-16 programs using the General Electric Computer Timesharing facility.
National (35 pg.)

11 **"Microprocessors—Why They Evolved and What They Are"**
Offers background material and describes common microprocessor terms.
National Imp Brief 1 (2 pg.)

General (cont)

12 **"Increasing Throughput for IMP-16 Serial Input/Output"**
(MM5303)
Describes use of device to improve communication between microprocessor and peripheral with little increase in component count.
National AN-160 (7 pg.)

13 **"SC/MP Mates with Cassette Recorder"**
(SCMP)
Describes a method of storing digital information on cassette tape.
National AN-166 (12 pg.)

14 **"An Introduction to Microprocessors and RCA COSMAC COS/MOS Microprocessor"**
(CDP1800)
Gives a general description of microprocessor operation with some specific description of the COSMAC (CDP1800)
RCA ICAN-6416 (8 pg.)

Programming

15 **"S6800 Software Data Book"**
(S6800)
Description of instruction set.
American Microsystems (15 pg.)

16 **"S6800 Assembly Language Programming Manual"**
(S6800)
Extensive material on programming and use of the instruction set.
American Microsystems $15.00 (244 pg.)

17 **"HM-6100 Microprocessor Basic 4K Software"**
(HM6100)
Describes the Digital Equipment Corp. PDP-8 software.
Harris Application Note HM003 (4 pg.)

18 **"HM-6100 ROM Based Subroutine Calls"**
(HM 6100)
Describes two methods for returning to the proper program location after executing a subroutine.
Harris Application Note HM008 (4 pg.)

19 **"Intellec 8/Mod 80 Microcomputer Development System Reference Manual"**
(8080)
Discusses the design concepts and the use of the components of this system which can simplify the development of systems using the 8080 microprocessor.
Intel. Available with system. (152 pg.)

20 **"Intellec 8/Mod 8 Microcomputer System Operator's Manual"**
(8008)
Describes how to operate and run programs on the INTELLEC 8 computer, which is a system development tool for 8008 microcomputer users.
Intel. Available with system. (145 pg.)

21 **"Interp/80 User's Manual"**
(8080)
Describes the use of a FORTRAN IV program called INTERP/80. The program provides software simulation of the 8080 CPU along with execution monitoring commands to aid program development for the MCS-80.
Intel $2.00 (32 pg.)

22 **"Series 3000 Cross Microprogramming System CROMIS Reference Specification"**
(3000)
Describes the CROMIS microprogramming system for the 3000 series computing elements. It supports the user who wants to generate microcode.
Intel $5.00 (77 pg.)

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MICROPROCESSORS

Programming (cont)

1 **"8008 and 8080 PL/M Programming Manual"**
(8008, 8080)
Tutorial introduction to PL/M language as it applies to these processors.
Intel. Price $5.00 (70 pg.)

2 **"8080 Assembly Language Programming Manual"**
(8080)
Discusses the assembly language format and tells how to write assembly language programs for the 8080 microprocessor.
Intel $5.00 (85 pg.)

3 **"8008 PL/M Compiler Operators Manual"**
(8008)
Describes operation of the 8008 PL/M cross compiler.
Intel. Price $5.00 (42 pg.)

4 **"8080 PL/M Compiler Operators Manual"**
(8080)
Discusses the two distinct programs that must be executed consecutively to perform a compilation of a PL/M source program.
Intel. Price $5.00 (45 pg.)

5 **Series 3000 Microprogramming Manual"**
(3000)
Fundamentals of the 3000 series microprocessor and Cross Microprogramming System are described. Presents XMAS, XMAP languages and microprogramming techniques.
Intel $5.00 (73 pg.)

6 **"IM6100 CMOS Microprocessor Basic 4K Software"**
(IM6100)
Describes use of the Digital Equipment Corp. PDP-8 software.
Intersil Application Bulletin M003 (7 pg.)

7 **"ROM Based Subroutine Calls with the IM6100"**
(IM6100)
Describes two methods for returning to the proper program location after executing a subroutine.
Intersil Application Bulletin M008 (6 pg.)

8 **"F8 Programmer's Guide"**
(F8)
Describes how to write programs for the F8 microprocessor system which cause the system to function as a discrete logic element.
Mostek $5.95 (304 pg.)

9 **"M6800 Evaluation Module Users Guide"**
(M6800)
Provides general information, installation instructions, preparation and operating procedures for the M6800 evaluation module.
Motorola $5.00)150 pg.)

10 **M6800 Microprocessor Programming Manual"**
(M6800)
Provides information needed to program the unit, discusses the instruction set, source language, assembler, simulator, Build-Virtual-Machine and HELP programs. Gives program examples.
Motorola $10.00 (303 pg.)

11 **"A Microprogram Development System"**
(IMP-16)
Describes the application of microprogramming to LSI processors and the advantages of a microprogram development system for hardware and software.
National AN-123 (6 pg.)

12 **"IMP-4 Programming Techniques"**
Discusses subtle considerations for programming the IMP-4 including subroutines, using the address register, decimal add and multi-precision arithmetic.
National AN-136 (6 pg.)

Programming (cont)

13 **"IMP-8 Assembler Manual"**
(IMP-8)
Presents preliminary information on the use of IMP-8 assembler language.
National (60 pg.)

14 **"IMP-8 Programming Manual"**
(IMP-8)
Provides information for the programming of the IMP-8 family of microprocessors and microcomputers.
National (111 pg.)

15 **"IMP-8 Utilities Reference Manual"**
(IMP-8)
Provides information on the IMP-8 debugging program, loader programs, the standard teletype and I/O package, and the paper tape-punch package.
National (57 pg.)

16 **"IMP-16 Assembler Program Description Manual"**
(IMP-16)
Describes the internal structure of the IMP-16 Assembler. It covers the general organization, functions required for conversion to operate on a different machine, and a detailed subroutine and data description.
National (105 pg.)

17 **"IMP-16 Microsymbolic Assembler"**
(IMP-16)
The microsymbolic assembler is a collection of routines that make it possible to write microprograms for the IMP-16 in symbolic language. This manual describes the statements, character set and basic programming elements.
National (21 pg.)

18 **"Installation of IMP-16 Assembler on System 360/370 Operator Manual"**
(IMP-16)
Provides information for installing the IMP-16 assembler and punch programs on an IBM 360/370 computer.
National (18 pg.)

19 **"IMP-16 Programming Techniques"**
(IMP-16)
Discusses several aspects of the instruction set to enable programmer to code more efficiently. Includes discussion of subroutines, subroute parameter passing, recursive subroutines, as well as sample programs.
National AN-111 (6 pg.)

20 **"Program Development Guide for the COSMAC Microprocessor"**
(CDP1800)
This manual reviews the system architecture, describes two levels of COSMAC assembly language and describes the COSMAC software development package.
RCA MPM-102 $10.00 (97 pg.)

21 **"Binary Arithmetic Routines"**
(2650)
Covers routines for binary addition, subtraction, multiplication and division.
Signetics AS53 (15 pg.)

22 **"Conversion Routines"**
(2650)
Covers Binary to BCD, BCD to ASCII, Hexadecimal to ASCII and vice versa.
Signetics AS54 (17 pg.)

23 **"Serial Input/Output"**
(2650)
Covers use of the Sense/Flag capability for serial input/output.
Signetics AS50 (3 pg.)

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MICROPROCESSORS

Programming (cont)

1 **"Bit and Byte Testing Procedures"**
(2650)
Describes several methods of testing the contents of the internal registers.
Signetics AS51 (4 pg.)

2 **"General Delay Routines"**
(2650)
Covers software routines to generate time delays.
Signetics AS52 (3 pg.)

3 **"Support Software for Use with the NCSS Timesharing System"**
(2650)
Covers a cross-assembler, cross-simulator and two utility programs (to load the 2650 and to burn PROMs.)
Signetics SP52 (7 pg.)

4 **"Simulator, Version 1.2"**
(2650)
Changes to the simulator.
Signetics SP53 (1 pg.)

5 **"2650 Initialization"**
(2650)
Covers start up procedures.
Signetics MP51 (1 pg.)

6 **"Absolute Object Format"**
(2650)
Describes the format of the absolute code.
Signetics SS51 (1 pg.)

7 **"Pipbug"**
(2650)
Program for the 2650 PC1001 demonstration card.
Signetics SS50 (13 pg.)

8 **"2650 Demo System"**
(2650)
Complete demonstration system when used with the 2650 PC1001.
Signetics SP51 (7 pg.)

9 **"2650 Evaluation Printed Circuit Board"**
(2650)
Covers features and connections for this card level evaluation and design tool.
Signetics SP50 (14 pg.)

Systems

10 **"A Computer Control Unit Using the AM2909"**
(AM2909)
Covers application of the AM2909 Microprogram Sequencer in the construction of computer control units.
Advanced Micro Devices Application Note (11 pg.)

11 **"S6800 Microprocessor Hardware Book"**
(S6800)
Provides System description and data sheets.
American Microsystems (72 pg.)

12 **"S6800 Hardware Reference Manual"**
(S6800)
Detailed descriptions of the system operation.
American Microsystems $15.00 (225 pg.)

Systems (cont)

13 **"Prototyping Board Manual"**
(S6800)
Describes system, software, operating procedures, troubleshooting procedures, and lists parts and instruction set for the system.
American Microsystem (94 pg.)

14 **"F8 Microprocessor Application Manual"**
(F8)
Covers details concerning bit manipulation, RAM expansion, extension of the I/O ports, subroutines and boot strap loaders.
Fairchild

15 **"Static Memory Systems Utilizing the HM-6100"**
(HM6100)
Describes CMOS, nonvolatile CMOS and NMOS memory systems.
Harris Application Note HM004 (7 pg.)

16 **"HM-6100 CMOS Microprocessor Teletype Interface"**
(HD6402, HM6100)
Describes a teletype interface using the HM6100 and a UART.
Harris Application Note HM005 (7 pg.)

17 **"HM-6100 Operator Console"**
(HM6100)
Describes the 6900-CONTRL console for the prototyping system.
Harris Application Note HM006 (4 pg.)

18 **"HM-6100 CMOS Microprocessor Memory Extension"**
(HM6100)
Discusses a memory extension controller to increase the memory from 4096 to 32,768 words.
Harris Application Note HM007 (4 pg.)

19 **"Intellec 8/Mod 80 Operators Manual"**
(8080)
Describes how to operate and run programs on the Intellec 8 computer, a design development tool 8080 microcomputer users.
Intel (available with system) (143 pg.)

20 **"Using the 8251 Universal Synchronous/Asynchronous Receiver/Transmitter"**
See listing under Digital-Data Transmission (Intel)

21 **"8255 Programmable Peripheral Interface Applications"**
(8255)
Provides hardware and software information for this byte oriented I/O device. Examples cover character printer, paper tape and 8080-8080 interface applications.
Intel Application Note AP-15 $1.00 (32 pg.)

22 **"8080 Microcomputer Systems User's Manual"**
(8080A)
Data sheets, architecture, timing requirements, and instruction sets for the MSC80 family.
Intel $5.00 (238 pg.)

23 **"8080/8080A Microcomputer"**
(8080/8080A)
Presents device, failure mechanisms, testing methods and results.
Intel RR-10 (13 pg.

24 **"Memory-Mapped I/O and Vectored Interrupts for Intel 4-Bit Microcomputer Systems"**
(4009, 4289)
Describes the expansion to 16 or 256 4-bit input ports, to 64 8-bit input ports, to vectored interupts, to vectored inputs and to 128 output ports.
Intel Application Note AP-19 (6 pg.)

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Systems (cont)

1 **"Static Memory Systems for the IM6100"**
(IM6100)
Describes CMOS, nonvolatile CMOS and NMOS memory systems for the IM6100.
Intersil Application Bulletin M004 (14 pg.)

2 **"Teletype Interface for the IM6100 CMOS Microprocessor"**
(IM6100)
Describes a teletype interface using the IM6100 and a UART.
Intersil Application Bulletin M005 (10 pg.)

3 **"IM6100 Operator Console"**
(IM6100)
Describes the 6900-CONTRL console for the prototyping system.
Intersil Application Bulletin M006 (17 pg.)

4 **"IM6100 CMOS Microprocessor Memory Extension"**
(IM6100)
Discusses a memory extension controller to increase the memory from 4096 to 32,768 words.
Intersil Application Bulletin M007 (6 pg.)

5 **"A Powerful Microprogram Controller: The 67110"**
(65110)
Describes features of the device including organization, internal interrupts, and memory expansion.
Monolithic Memories (5 pg.)

6 **"5701/6701: 4-Bit Expandable Bipolar Microcontroller"**
(5701, 6701)
Provides functional descriptions of the device, instruction set, timing, and more.
Monolithic Memories Application Note (23 pg.)

7 **"12/12K Memory System for the MK5065 Microprocessor"**
(MK4096, MK5065)
Describes a complete 12K×8 or 16K×8 memory system for use with the MK5065 microprocessor.
Mostek (6 pg.)

8 **"F8 Microprocessor Hardware Support-Evaluation Kit"**
(F8)
Describes this kit and its use. Includes a sample program to acquaint the user with F8 machine language and to program the kit.
Mostek (20 pg.)

9 **"F8 Preliminary Data Book"**
(F8)
Describes the timing, signal sequences, and chip interactions as well as provides detailed system information.
Mostek (125 pg.)

10 **"Expanding Mostek's F8 Microprocessor External Interrupt Capability"**
(F8)
A detailed discussion of servicing control inputs in a F8 based system with emphasis on implementing interrup driven systems.
Mostek (12 pg.)

11 **"Subroutine Neting and Multiple Interrupt Handling using Mostek's F8 Microprocessor"**
(F8)
Discusses the use and implementation of subroutines and interrupts as they apply to programming an F8 based system.
Mostek (16 pg.)

12 **"M6800 System Microcomputer System Design Data"**
(M6800)
Describes the family of parts including data sheets.
Motorola. (165 pg.)

Systems (cont)

13 **"Analog-to-Digital Conversion Techniques with the M6800 Microprocessor System"**
(MC1405, M6800)
Describes successive approximation and dual ramp techniques for A/D conversion using the M6800. Gives flow diagrams, source programs and schematics. Appendix gives program for binary to BCD conversion.
Motorola AN-757 (35 pg.)

14 **"Device Operation and System Implementation of the Asynchronous Communications Interface Adapter (MC6850)**
See listing under Digital-Data Transmission (Motorola)

15 **"GCP/P Product Description"**
(GCP/P)
Delineates the system, gives a functional description of the CROM and RALU devices, and presents the general purpose macroinstruction set. Appendices cover a microprogram to implement the IMP-16 instructions set and the use of the RALU status flag.
National (61 pg.)

16 **"IMP-4 Technical Description"**
(IMP-4)
Describes the general purpose instruction set, gives functional and system descriptions, describes the development system and shows specific programming examples.
National (77 pg.)

17 **"Designing with the IMP Chip Set"**
(IMP-16)
Describes some of the major considerations in the implementation of 4 to 32 bit systems using the IMP series of devices. A 16 bit system is covered in detail.
National AN-141 (10 pg.)

18 **"IMP-4A Base Memory Architecture"**
(IMP-4A)
Describes a memory that taxes the capabilities of the IMP-4A microprocessor system.
National AN-137 (4 pg.)

19 **"IMP-8C Application Manual"**
(IMP-8)
Describes the IMP-8C's operational features, functional and logic operation, and input/output interfacing in sufficient detail to permit the user to adapt the card to various applications.
National (119 pg.)

20 **"IMP-8C/200 Microprocessor, IMP-8P Microcomputer Product Description"**
(IMP-8)
Describes the IMP-8C microprocessor card and the IMP-8P prototyping tool (microcomputer) as systems.
National (10 pg.)

21 **"IMP-16C Peripheral Interfacing Simplified"**
(IMP-16C)
Explores techniques for interfacing peripheral devices to the microprocessor.
National AN-124 (4 pg.)

22 **"IMP-16 Interrupts"**
(IMP-16)
Describes various type of interrupts, including an overview of interrupt structure, example of interrupt request and service, multilevel and control panel interrupts.
National AN-107 (23 pg.)

23 **"Increasing the Number of Control Flags and Jump Conditions in the IMP-16C"**
(IMP-16C)
Describes simple and economical method of increasing the number of testable jump conditions and the number of control flags on the IMP-16C microprocessor.
National AN-101 (4 pg.)

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MICROPROCESSORS

Systems (cont)

1 **"IMP-16-L Product Description"**
Describes the features of the IMP-16L general microcomputer system.
National (8 pg.)

2 **"Clock-Hold Schemes For the IMP Microprocessor Family"**
(IMP-8C, IMP-16C)
Presents scheme to extend the clock-hold function for additional periods of the main system clock, using the DM8570 shift register.
National AN-105 (4 pg.)

3 **"PACE Technical Description"**
(PACE)
Defines and explains how to use the hardware and software items that support the PACE system.
National (96 pg.)

4 **"Applications of LSI Processors"**
(IMP-16)
Describes system architecture and operation of IMP-16C, 16-bit parallel processor with self-contained memory. Describes applications in a a data communication link analyzer, in point-of-sales and in retailing systems.
National AN-98 (8 pg.)

5 **"POWR I/O CROM Technical Description"**
(IMP-16)
Describes the instruction repertoire and use of this unit which expands the variety of memory and input/output operations of the IMP-16.
National (22 pg.)

6 **"Using a Microprocessor Beyond Apparent Speed"**
(IMP-16)
Covers the concept of cycle stealing, a technique in which a peripheral device communicates directly with memory or another peripheral device while the CPU is doing work other than using the data and address buses.
National AN-142 (6 pg.)

7 **"SC/MP Technical Description"**
(SCMP)
Describes the SC/MP system plus its hardware and systems.
National (64 pg.)

8 **"IMP-16L DMA—What It Is and How to Use It"**
(IMP-16)
Discusses general theory of the DMA Bus, gives examples of priority expansion and data transfer.
National AN-135 (6 pg.)

9 **"Data Acquisition System Interface to Computers"**
See listing under (Linear) Converters (National)

10 **"User Manual for the COSMAC Microprocessor"**
(CDP1800)
Describes the COSMAC microprocessor architecture and its instructions with examples of each instruction. Illustrates methods of adding external memory and describes machine coding techniques.
RCA MPM-101 $5.00 (65 pg.)

11 **"Guide to better Handling and Operation of CMOS Integrated Circuits"**
Recommends specific handling and operating practices to minimize the probability of damage in manufacturing and field environments.
RCA ICAN-6525 (5 pg.)

12 **"Analog-to-Digital Converter for Use with RCA COSMAC Development Systems"**
(CPD1800)
Circuit and program to use the Burr Brown ADC55 12-bit converter.
RCA ICAN-6490 (2 pg.)

Systems (cont)

13 **"Interrupt Priority Resolution Circuit for Use with RCA COSMAC Development Systems"**
(CDP1800)
Circuit and program for use when resolution in software is not sufficiently efficient.
RCA ICAN-6485 (3 pg.)

14 **'Adding Two-Level I/O Interface Capability to RCA COSMAC Development Systems"**
(CDP1800)
Circuit to expand I/O cabability.
RCA ICAN-6486 (2 pg.)

15 **"Alphanumeric Display for Use with RCA COSMAC Development Systems"**
(CDP1800)
Circuit and program for self-scanning dot-matrix display.
RCA ICAN-6488 (3 pg.)

16 **"Digital-to-Analog Converter for Use with RCA COSMAC Development Systems**
(CDP1800)
Circuit and program using the Burr-Brown DAC50 12-bit converter.
RCA ICAN-6489 (3 pg.)

17 **"PROM Programmer for RCA COSMAC Development Systems"**
(CPD1800)
Circuit and program to program, copy, verify and list contents of 1702, 2704 and 2708 PROM's.
RCA ICAN-6491 (8 pg.)

18 **"Hexadecimal Keyboard Interface for Use with RCA COSMAC Development Systems"**
(CPD1800)
Circuit and program including debounce routine for 16 key keyboard.
RCA ICAN-6516 (2 pg.)

19 **"Using the RCA CPD1802 Microprocessor in CDP1801 Designs"**
(CDP1800)
Explains hardware and software differences between CDP1802 and CDP1801.
RCA ICAN-6509 (10 pg.)

20 **"Programmable Interval Timer and Counter for Use with RCA COSMAC Development Systems"**
(CDP1800)
Gives the circuits and logic diagrams for a programmable interval timer and counter for use with the COSMAC development systems. Discusses the commands used for its operation and gives four sample programs.
RCA ICAN-6482

21 **"Register-Based Output Functions for RCA COSMAC Microprocessors"**
(CDP1802, CDP1852)
Describes circuits using the CDP1852 I/O port for outputting information from any of the 16 general purpose scratch pad registers of the CDP1802 microprocessor)
RCA ICAN-6562

22 **"Design of Clock Generators for Use with RCA COSMAC Microprocessor"**
(CDP1802)
Describes a crystal controlled clock generator using on-chip circuits and crystal and RC generators using external circuits.
RCA ICAN-6565

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MICROPROCESSORS

Systems (cont)

1 **"The Microcontroller"**
(300)
Provides system overview, instruction set, programming examples, and system applications.
Scientific Microsystems Application Guide (42 pg.)

2 **"Microprocessor Prototyping Card"**
(2650)
Describes features of the 2650PC1001 microcomputer.
Signetics Application Memo (2 pg.)

3 **"A Guide to the Selection of Support Components for the Series 3000 Microprocessor"**
(N3001, N3002)
Categorizes the various components used to implement major sections of a typical microprocessor system.
Signetics AM-1 (4 pg.)

4 **A User's Guide to the Series 3000 Microprocessor Chip Set"**
(N3001, N3002)
Describes devices, instruction sets. Design examples included.
Signetics AM-2 (14 pg.)

5 **"Address and Data Bus Interfacing Techniques"**
(2650)
Discusses address and data bus drive requirements. Covers methods for increasing the system drive capability.
Signetics MP53 (8 pg.)

6 **"How to Design with the Control Store Sequencer, 8X02"**
(8X02)
Presents a functional description and gives microprogramming system suggestions.
Signetics Bipolar Application Memo 3 (6 pg.)

7 **"Interfacing the 8700 A/D Converter with the 8080 μP System"**
(8700, 8701, 8702)
Presents use of the 8700 A/D converter with the 8080 microprocessor. Provides techniques for interfacing the two and methods for handling multiple converters with increased throughput.
Teledyne Semiconductor AN-8 (6 pg.)

8 **"Minimum System Design TMS 9900 16-bit Microprocessor"**
(TMS 9900)
Explains system design, system performance, and minimum system configuration.
Texas Instruments CA-184A (7 pg.)

9 **"TMS 5501 I/O in TMS 8080A μP Systems"**
(TMS5501, TMS8080A)
Describes operation and use of this input/output controller.
Texas Instruments CA-185A (18 pg.)

10 **"Software Design for Microprocessors"**
(SBP0400, TMS1000, TMS5501, TMS8080, TMS9900)
Presents basic microprocessor fundamentals. Includes such topics as basic terms, basic machine architecture, instruction sets, and programming. Sample design problems are examined.
Texas Instruments $12.50 (385 pg.)

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MILITARY PARTS DIRECTORY

This section is divided into three parts: a table of those manufacturers willing to perform MIL-STD-883 screening, a two way military to commercial cross reference index, and the Qualified Parts List broken down into functions. It not only shows what devices are on the list and which manufacturers supply them, but also it decodes the military numbers into familiar terms.

how to use the military parts directory

The next page contains a table showing the manufacturers who have advised that they want to screen devices to MIL-STD-883 and/or perform other environmental screening. The table also indicates which companies are currently qualified to supply one or more devices on the QPL list. Such achievement is apt to indicate that these companies are well equipped to perform 883 testing. The following page provides convenient cross references between M38510 numbers and their commercial equivalents; all these devices are listed in the latest QPL.

The heart of this section is the functional QPL parts list. It is based on the latest Defense Electronics Supply Center Qualified Products List (QPL-38510-XX) at the time of publication. The revision and date of this list are indicated at the bottom of each page. Like the Master Selection Guide, the devices are classified my major functions; within each function the devices are arranged in alphanumeric order, which automatically groups CMOS together, 5400 Series together, etc.

A complete military part number includes a three letter suffix signifying the device class and packaging. The definitions of these letters are given in the Part Number Guide under "JAN Nomenclature." All the devices listed here meet class B and C requirements, a few devices (CMOS) meet class A specifications. The package styles and lead finishes that each manufacturer is qualified to supply can be determined by consulting the official QPL or by contacting the individual manufacturers. Once you have found the names of the companies you need to contact, you can reach them by using the information in the Manufacturers and Distributors Directory.

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MANUFACTURER	MIL-M-38510 QPL				MIL-STD-883 SCREENING			OTHER SCREENING	
	Linear	TTL	Other Bipolar	CMOS	Class A	Class B	Class C	Military	Industrial
Advanced Micro Devices	X	X			X	X	X	X	X
American Micro-systems, Inc.						X	X	X	X
Analog Devices						X	X		
Beckman Instruments					X	X	X	X	X
Burr-Brown Research						X	X	X	X
Collins					X	X	X	X	X
Electronic Arrays						X	X	X	X
EMM/Semi					X	X	X	X	X
Exar Integrated Systems						X	X	X	X
Fairchild Semiconductor	X	X	DTL		X	X	X	X	X
General Instrument						X	X		X
Harris Semiconductor			PROM		X	X	X	X	X
Hughes					X	X	X	X	X
Hybrid Systems					X	X	X	X	X
Intel						X	X	X	X
International Microcircuits								X	X
Intersil	X				X	X	X	X	X
ITT Semiconductor		X	DTL		X	X	X	X	X
Lithic Systems									X
LSI Computer Systems					X	X	X	X	X
Micro Networks						X	X	X	X
Micropac					X	X	X		
Mitel Semiconductor					X	X	X	X	X
Monolithic Memories					X	X	X	X	X
Mostek						X			
Motorola Semiconductor		X	ECL		X	X	X	X	X
National Semiconductor	X	X		X	X	X	X	X	X
NEC Microcomputers						X	X		
Nitron						X	X	X	X
Nortec						X	X	X	X
Plessey Semiconductor					X	X	X		
Power Monolithics									X
Precision Monolithics					X	X	X	X	X
Ragen Semiconductor					X	X	X	X	X
Raytheon Semiconductor					X	X	X	X	X
RCA Solid State				X	X	X	X	X	X
Scientific Micro Systems								X	X
Signetics	X	X			X	X	X	X	X
Silicon General					X	X	X	X	X
Siliconix					X	X	X	X	X
SMC Microsystems						X	X	X	X
Solid State Scientific					X	X	X	X	X
Solitron					X	X	X	X	X
Sprague Electric					X	X	X	X	X
Stewart Warner					X	X	X	X	X
Teledyne Philbrick					X	X	X	X	X
Teledyne Semiconductor						X	X	X	X
Texas Instruments	X	X			X	X	X	X	X

Explanation:
The "MIL-M-38510" section indicates the IC manufacturers currently providing Q.P.L. ICs. More detailed information on the specific devices is given in the Qualified Products lists which follow.

The "MIL-STD-883 Screening" section lists those manufacturers who are both set up and actively want to screen devices to the levels indicated.

"Other Screening" shows those who report that they want business calling for special military and industrial environment screening procedures.

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Cross Reference Commercial to Military

Device	M38510/
HPROM0512	20101
101A	10103
10501	06001
10502	06002
10505	06003
10506	06004
10507	06005
10509	06006
108A	10104
4000	05201
4001	05202
4002	05203
4006	05701
4007	05301
4009	05501
4010	05502
4011	05001
4012	05002
4013	05101
4014	05702
4015	05703
4017	05601
4018	05602
4019	05302
4020	05603
4021	05704
4022	05604
4023	05003
4024	05605
4025	05204
4027	05102
4030	05303
4031	05705
4041	05505
4049	05503
4050	05504
54H00	02304
54H01	02306
54H04	02305
54H08	15501
54H10	02303
54H101	02205
54H103	02206
554H11	15502
43H20	02302
54H21	15503
43H22	02307
54H30	02301
54H40	02401
54H50	04001
54H51	04002
54H53	04003
54H54	04004
54H55	04005
54H72	02201
54H73	02202
54H74	02203
54H76	02204
54LS00	30001
54LS02	30301
54LS03	30002
54LS04	30003
54LS05	30004
54LS08	31004
54LS10	30005
54LS11	31001
54LS12	30006
54LS15	31002
54LS20	30007
54LS21	31003
54LS22	30008
54LS266	30303
54LS27	30302
54LS30	30009
54LS32	30501
54LS37	30202
54LS51	30401
54LS54	30402
54LS86	30502
54L00	02004
54L03	02006
54L04	02005
54L10	02003
54L20	02002
54L30	02001
54L71	02101
54L72	02102
54L73	02103
54L74	02105
54L78	02104
54L95	02801
54S00	07001
54S02	07301
54S03	07002
54S04	07003
54S05	07004
54S10	07005
54S11	08001
54S133	07009
54S134	07010
54S140	08101
54S15	08002
54S20	07006
54S22	07007
54S40	07201
54S51	07401
54S64	07402
54S65	07403
54S74	07101
54S86	07501
5400	00104
5401	00107
5402	00401
5403	00109
5404	00105
5405	00108
5406	00801
5407	00803
5408	01601
5409	01602
5410	00103
54107	00203
5412	00106
54116	01503
54121	01201
54122	01202
54123	01203
54126	15302
54145	01005
54150	01401
54151	01406
54153	01403
5416	00802
54160	01303
54161	01306
54162	01305
54163	01304
54164	00903
5417	00804
54174	01701
54175	01702
54180	01901
54181	01101
54182	01102
54192	01308
54193	01309
54194	00905
54195	00906
5420	00102
5423	00402
5425	00403
5426	00805
5427	00404
5430	00101
5437	00302
5438	00303
5440	00301
5442	01001
5443	01002
5444	01003
5445	01004
5448	01008
5449	01009
5450	00501
5451	00502
5453	00503
5454	00504
5470	00206
5472	00201
5473	00202
5474	00205
5475	01501
5476	00204
5477	01502
5479	00207
5482	00601
5483	00602
5485	15001
5486	00701
5490	01307
5492	01301
5493	01302
5495	00901
5496	00902
55107	10401
55108	10402
55113	10405
55114	10403
55115	10404
710	10301
723	10201
741	10101
747	10102
930	03001
9304	00603
9309	01404
9312	01402
9314	01504
9322	01405
935	03002
936	03003
946	03004
962	03005

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Cross Reference Military to Commercial

Device	M38510/
00101	5430
00102	5420
00103	5410
00104	5400
00105	5404
00106	5412
00107	5401
00108	5405
00109	5403
00201	5472
00202	5473
00203	54107
00204	5476
00205	5474
00206	5470
00207	5479
00301	5440
00302	5437
00303	5438
00401	5402
00402	5423
00403	5425
00404	5427
00501	5450
00502	5451
00503	5453
00504	5454
00601	5482
00602	5483
00603	9304
00701	5486
00801	5406
00802	5416
00803	5407
00804	5417
00805	5426
00901	5495
00902	5496
00903	54164
00905	54194
00906	54195
01001	5442
01002	5443
01003	5444
01004	5445
01005	54145
01008	5448
01009	5449
01101	54181
01102	54182
01201	54121
01202	54122
01203	54123
01301	5492
01302	5493
01303	54160
01304	54163
01305	54162
01306	54161
01307	5490
01308	54192
01309	54193
01401	54150
01402	9312
01403	54153
01404	9303
01405	9322
01501	5475
01501	5475
01502	5477
01503	54116
01504	9314
01601	5408
01602	5409
01701	54174
01702	54175
01901	54180
02001	54L30
02002	54L20
02003	54L10
02004	54L00

Device	M38510/
02005	54L04
02006	54L03
02101	54L71
02102	54L72
02103	54L73
02104	54L78
02105	54L74
02201	54H72
02202	54H73
02203	54H74
02204	54H76
02205	54H101
02206	54H103
02301	54H30
02302	54H20
02303	54H10
02304	54H00
02305	54H04
02306	54H01
02307	54H22
02401	54H40
02801	54L95
03001	930
00302	935
03003	936
03004	946
00305	962
04001	54H50
04002	54H51
04003	54H53
04004	54H54
04005	54H55
05001	4011
05002	4012
05003	4023
05101	4013
05102	4027
05201	4000
05303	4030
05202	4001
05203	4002
05204	4025
05301	4007
05302	4019
05501	4009
05502	4010
05503	4049
05504	4050
05505	4041
05601	4017
05602	4018
05603	4020
05604	4022
05605	4024
05701	4006
05702	4014
05703	4015
05704	4021
05705	4031
06001	10501
06002	10502
06003	10505
06004	10506
06005	10507
06006	10509
07001	54S00
07002	54S03
07003	54S04
07004	54S05
07005	54S10
07006	54S20
07007	54S22
07009	54S133
07010	54S134
07101	54S74
07201	54S40
07301	54S02
07401	54S51
07402	54S64
07403	54S65
07501	54S86
08001	54S11
08002	54S15
08101	54S140
10101	741

Cross Reference Military to Commercial

Device	M38510/
10102	747
10103	101A
10104	108A
10201	723
10301	710
10401	55107
10402	55108
10403	55114
10404	55115
10405	55113
15001	5485
15302	54126
15501	54H08
15502	54H11
15503	54H21
20101	HPROM0512
30001	54LS00
30002	54LS03
30003	54LS04
30004	54LS05
30005	54LS10
30006	54LS12
30007	54LS20
30008	54LS22
30009	54LS30
30202	54LS37
30301	54LS02
30302	54LS27
30303	54LS266
30401	54LS51
30402	54LS54
30501	54LS32
30502	54LS86
31001	54LS11
31002	54LS15
31003	54LS21
31004	54LS08

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Digital

ARITHMETIC FUNCTIONS

Device	M38510/	Description	Source
9304	00603	Dual Full Adder	Motorola
5482	00601	2-Bit Binary Full Adder	ITT Motorola
5483	00602	4-Bit Binary Full Adder (Look-Ahead Carry)	ITT Motorola Signetics TI
5485	15001	4-Bit Magnitude Comparator	Signetics
54181	01101	Arithmetic Logic/Function Gen.	Motorola Signetics
54182	01102	Look-Ahead Carry Generator	Motorola Signetics

BUFFERS, INVERTERS

935	03002	Hex Inverter	ITT
936	03003	Hex Inverter	ITT
4007	05301	Dual Complementary Pair plus Inverter	National RCA
4009	05501	Hex Buffer/Converter, Inverting	National RCA
4010	05502	Hex Buffer/Converter, Non-Inverting	National RCA
4041	05505	Quad True/ Complement Buffer	RCA
4049	05503	Hex Buffer/Converter, Inverting	National RCA
4050	05504	Hex Buffer/Converter, Non-Inverting	National RCA
5404	00105	Hex Inverter	Fairchild ITT Motorola National Signetics TI
5405	00108	Hex Inverter, O/C	Fairchild ITT Motorola National Signetics TI
5437	00302	Quad 2-Input NAND Buffer	ITT Motorola National Signetics TI
5438	00303	Quad 2-Input NAND Buffer, O/C	Fairchild Motorola National Signetics TI
5440	00301	Dual 4-Input NAND Buffer	Fairchild ITT Motorola National Signetics TI
54125/6	15301/2	Quad Gated Buffer, 3 State	Signetics
54H04	02305	Hex Inverter	Fairchild ITT Motorola Signetics TI
54H40	02401	Dual 4-Input NAND Buffer	Motorola Signetics TI
54LS04	30003	Hex Inverter	National Signetics
54LS05	30004	Hex Inverter, O/C	National Signetics
54LS37	30202	Quad 2-Input NAND Buffer	Signetics
54S04	07003	Hex Inverter	Signetics
54S05	07004	Hex Inverter, O/C	Signetics
54S40	07201	Dual 4-Input NAND Buffer	Signetics

COUNTERS

Device	M38510/	Description	Source
54L04	02005	Hex Inverter	National
4017	05601	Decade Counter/Divider, Decoded Output	RCA
4018	05602	Presettable Divide-by-N Counter	RCA
4020	05603	14-Bit Binary Counter	RCA
4022	05604	Divide-by-8 Counter/ Divider, Decoded Output	RCA
4024	05605	7-Bit Binary Counter	RCA
5490	01307	Decade Counter, Ripple	ITT Motorola
5492	01301	Divide-By-Twelve Counter (÷2, ÷6)	ITT Motorola Signetics
5493	01302	4-Bit Binary Counter	ITT Motorola Signetics
54160	01303	Synchronous Decade Counter	Motorola National Signetics
54161	01306	Synchronous 4-Bit Binary Counter	Motorola National Signetics
54162	01305	Fully Synchronous Decade Counter	Motorola National Signetics
54163	01304	Fully Synchronous 4-Bit Binary Counter	Motorola National Signetics
54192	01308	Decade Up/Down Counter	Motorola
54193	01309	Binary Up/Down Counter	Motorola

DECODERS

5442	01001	BCD-to-Decimal Decoder	ITT Motorola Signetics
5443	01002	Excess 3-to-Decimal Decoder	Motorola Signetics
5444	01003	Excess 3-Gray-to-Decimal Decoder	Motorola Signetics
5445	01004	BCD to Decimal Decoder, O/C	Motorola
5448	01008	BCD to Seven Segment Decoder/Driver with 30V Output	Motorola
5449	01009	BCD to 7 Segment Decoder, O/C	Motorola
54145	01005	BCD to 7 Segment Decoder	Motorola

DRIVERS

5406	00801	Hex Inverter Buffer/Driver, O/C High Voltage Output	Fairchild ITT Motorola National TI
5407	00803	Hex Buffer/Driver, O/C High Voltage Output	Fairchild ITT Motorola National TI
5416	00802	Hex Inverter Buffer/Driver, O/C High Voltage Output	Fairchild ITT Motorola National TI
5417	00804	Hex Buffer/Driver, O/C High Voltage Output	Fairchild ITT Motorola National TI

FLIP-FLOPS

Device	M38510/	Description	Source
4013	05101	Dual "D" Flip-Flop with Set/Reset	National RCA
4027	05102	Dual J-K Master-Slave Flip-Flop	National RCA
5470	00206	Positive Edge-Triggered J-K Flip-Flop	Fairchild ITT Motorola Signetics TI
5472	00201	J-K Master Slave Flip-Flop (AND Inputs)	ITT Motorola National Signetics TI
5473	00202	Dual J-K Master Slave Flip-Flop	ITT Motorola National Signetics TI
5474	00205	Dual D-Type Edge-Triggered Flip-Flop	Fairchild ITT National Signetics TI
5476	00204	Dual J-K Master Slave Flip-Flop with Preset and Clear	ITT National Signetics TI
5479	00207	Dual D-Type Flip-Flop	Motorola
54107	00203	Dual J-K Master Slave Flip-Flop	Motorola National Signetics TI
54174	01701	Hex D-Type Flip-Flop	Motorola National Signetics
54175	01702	Quad D-Type Flip-Flop	Motorola National Signetics
54H72	02201	J-K Master-Slave Flip-Flop (AND Inputs)	Motorola Signetics
54H73	02202	Dual J-K Master-Slave Flip-Flop	Signetics Motorola
54H74	02203	Dual D-Type Edge-Triggered Flip-Flop	Signetics
54H76	02204	Dual J-K Flip-Flop	TI Signetics
54H101	02205	J-K Negative Edge-Triggered Flip-Flop (AND-OR Inputs)	Motorola Signetics
54H103	02206	Dual J-K Negative Edge Triggered Flip-Flop	Motorola Signetics
54L71	02101	J-K Master-Slave Flip-Flop (AND-OR Inputs)	National
54L72	02102	J-K Master-Slave Flip-Flop (AND Inputs)	National
54L73	02103	Dual J-K Master-Slave Flip-Flop	National
54L74	02105	Dual D-Type Edge-Triggered Flip-Flop	National
54L78	02104	Dual J-K Master-Slave Flip-Flop	National
54S74	07101	Dual D Flip-Flop	Signetics

GATES, AND/NAND

930	03001	Dual 4-Input NAND Gate, Expandable	Fairchild ITT
946	03004	Quad 2-Input NAND Gate	Fairchild ITT
962	03005	Triple 3-Input NAND Gate	Fairchild ITT
4011	05001	Quad 2-Input NAND Gate	National RCA
4012	05002	Dual 4-Input NAND Gate	National RCA
4023	05003	Triple 3-Input NAND Gate	National RCA

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Gates, AND/NAND (cont)

Device	M38510/	Description	Source
5400	00104	Quad 2-Input NAND Gate	Fairchild ITT Motorola National Signetics TI
5401	00107	Quad 2-Input NAND Gate, O/C	Fairchild Itt Motorola National Signetics TI
5403	00109	Quad 2-Input NAND GATE, O/C	Fairchild ITT Motorola National Signetics TI
5408	01601	Quad 2-Input AND Gate	Fairchild ITT Motorola Signetics
5409	01602	Quad 2-Input AND Gate, O/C	Fairchild Motorola Signetics
5410	00103	Triple 3-Input NAND Gate	Fairchild ITT Motorola National Signetics TI
5412	00106	Triple 3-Input NAND Gate, O/C	TI
5420	00102	Dual 4-Input NAND Gate	Fairchild ITT Motorola National Signetics TI
5426	00805	Quad 2-Input NAND Gate, O/C	Signetics
5430	00101	8-Input NAND Gate	Fairchild ITT Motorola National Signetics TI
54H00	02304	Quad 2-Input NAND Gate	Fairchild ITT Motorola Signetics TI
54H01	02306	Quad 2-Input NAND Gate, O/C	Motorola Signetics TI
54H08	15501	Quad 2-Input AND Gate	Signetics
54H10	02303	Triple 3-Input NAND Gate	Fairchild ITT Motorola Signetics TI
54H11	15502	Triple 3-Input AND Gate	Signetics
54H20	02302	Dual 4-Input NAND Gate	Fairchild ITT Motorola Signetics TI
54H21	15503	Dual 4-Input AND Gate	Signetics
54H22	02307	Dual 4-Input NAND Gate, O/C	Fairchild Motorola Signetics
54H30	02301	8-Input NAND Gate	Fairchild ITT Motorola Signetics TI
54LS00	30001	Quad 2-Input NAND Gate	National Signetics TI
54LS03	30002	Quad 2-Input NAND Gate, O/C	National Signetics
54LS08	31004	Quad 2-Input AND Gate	National

Gates, AND/NAND (cont)

Device	M38510/	Description	Source
54LS10	30005	Triple 3-Input NAND Gate	National Signetics TI
54LS11	31001	Triple 3-Input AND Gate	National
54LS12	30006	Triple 3-Input NAND Gate, O/C	National Signetics
54LS15	31002	Triple 3-Input AND Gate, OC	National
54LS20	30007	Dual 4-Input NAND Gate	National Signetics
54LS21	31003	Dual 4-Input AND Gate	National Signetics
54LS22	30008	Dual 4-Input NAND Gate, O/C	National Signetics
54LS30	30009	8-Input NAND Gate	National Signetics
54L00	02004	Quad 2-Input NAND Gate	National
54L03	02006	Quad 2-Input NAND Gate, O/C	National
54L10	02003	Triple 3-Input NAND Gate	National
54L20	02002	Dual 4-Input NAND Gate	National
54L30	02001	8-Input NAND Gate	National
54S00	07001	Quad 2-Input NAND Gate	Signetics
54S03	07002	Quad 2-Input NAND Gate, O/C	Signetics
54S10	07005	Triple 3-Input NAND Gate	Signetics
54S11	08001	Triple 3-Input AND Gate	Signetics
54S15	08002	Triple 2-Input AND Gate, O/C	Signetics
54S20	07006	Dual 4-Input NAND Gate	Signetics
54S22	07007	Dual 4-Input NAND Gate, O/C	Signetics
54S133	07009	13-Input NAND Gate	Signetics
54S134	07010	12-Input NAND Gate, 3 State	Signetics

GATES, AND-OR/AND-OR-INVERT

4019	05302	Quad AND-OR Select GAte	National RCA
5450	00501	2-2-Input AOI Gate, Expandable	ITT Motorola National Signetics TI
5451	00502	2-2-Input AOI Gate, Expandable	ITT Motorola National Signetics TI
5453	00503	2-2-2-2-Input AOI Gate, Expandable	ITT Motorola National Signetics TI
5454	00504	2-2-2-2-Input AOI Gate	ITT Motorola National Signetics TI
54H50	04001	2-2-Input AOI Gate, Expandable	Motorola Signetics
54H51	04002	Dual 2-2-Input AOI Gate	Motorola Signetics
54H53	04003	2-2-2-3 Input AOI Gate, Expandable	Motorola Signetics
54H54	04004	2-2-2-3-Input AOI Gate	Motorola Signetics
54H55	04005	4-4-Input AOI Gate, Expandable	Motorola Signetics

Gates, AND-OR/AND-OR-INVERT (cont)

Device	M38510/	Description	Source
54LS51	30401	Dual 2/3-Input AOI Gate	National Signetics TI
54LS54	30402	2-2-2-3-Input AOI Gate	National TI
54S51	07401	2-2-Input AOI Gate	Signetics
54S64	07402	4-2-3-2 Input AOI Gate	Signetics
54S65	07403	4-2-3-2 Input AOI Gate, O/C	Signetics
5486	00701	Quad 2-Input Exclusive OR Gate	Fairchild ITT Motorola Signetics TI

GATES, EXCLUSIVE OR/NOR

4030	05303	Quad Exclusive OR Gate	National
54LS86	30502	Quad 2-Input Exclusive OR	National
54LS266	30303	Quad 2-Input Exclusive NOR Gate, O/C	TI
54S86	07501	Quad 2-Input Exclusive OR Gate	Signetics
10507	06005	Triple 2-Input Exclusive OR/NOR Gate	Motorola

GATES, OR/NOR

4000	05201	Dual 3-Input NOR Gate plus Inverter	RCA
4001	05202	Quad 2-Input NOR Gate	National RCA
4002	05203	Dual 4-Input NOR Gate	National RCA
4025	05204	Triple 3-Input NOR Gate	National RCA
5402	00401	Quad 2-Input NOR Gate	Fairchild ITT Motorola National Signetics TI
5423	00402	Dual 4-Input NOR Gate with Strobe, Expandable	Motorola TI
5425	00403	Dual 4-Input NOR Gate with Strobe	Motorola TI
5427	00404	Triple 3-Input NOR Gate	Fairchild Motorola TI
54LS02	30301	Quad 2-Input NOR Gate	Signetics TI
54LS27	30302	Triple 3-Input NOR Gate	TI Signetics
54LS32	30501	Quad 2-Input OR Gate	National Signetics
54S02	07301	Quad 2-Input NOR Gate	Signetics
10501	06001	Quad 2-Input OR/NOR Gate	Motorola
10502	06002	Quad 2-Input Gate (3 NOR, 1 OR/NOR)	Motorola
10505	06003	2-3-2-Input OR/NOR Gate	Motorola
10506	06004	4-3-3-Input OR/NOR Gate	Motorola
10509	06006	4-5-Input OR/NOR Gate	Motorola

LATCHES

9314	01504	Quad Multifunction Latch	Motorola

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Latches (cont)

Device	M38510/	Description	Source
5475	01501	Quad Bistable Latch, Complementary Output	Motorola Signetics
5477	01502	Quad Bistable Latch	Motorola Signetics
54116	01503	Dual 4-Bit Latch with Clear	Signetics

MULTIPLEXERS

9309	01404	Dual 4-Input Multiplexer	AMD ITT Motorola Signetics
9312	01402	8-Channel Data Selector/ Multiplexer	AMD ITT Motorola
9322	01405	Quad 2-Input Data Selector/ Multiplexer (Non-Inverting)	AMD ITT Motorola Signetics
54150	01401	16-Channel Data Selector/ Multiplexer	Signetics
54151	01406	8-Input Multiplexer	Motorola Signetics
54153	01403	Dual 4-Channel Data Selector/Multiplexer	Motorola National Signetics

MULTIVIBRATORS

54121	01201	Monostable Multivibrator	ITT Motorola Signetics
54122	01202	Retriggerable Monostable Multivibrator with Clear	Motorola
54123	01203	Dual Retriggerable Monostable Multivibrator with Clear	AMD Motorola Signetics

MISCELLANEOUS

54180	01901	9-Bit Odd/Even Parity Generator/Checker	Motorola Signetics

Interface

LINE DRIVERS AND RECEIVERS

54S140	08101	Dual 4-Input Positive NAND Line Driver	Signetics
55107	10401	Differential Line Receiver	TI
55108	10402	Differential Line Receiver	Fairchild TI
55113	10405	Dual Differential Line Driver, Three-State	TI
55114	10403	Dual Differential Line Driver	AMD Fairchild
55115	10404	Dual Differential Line Receiver	AMD Fairchild

Linear

AMPLIFIERS

101A	10103	Operational Amplifier	AMD Fairchild National
108A	10104	Operational Amplifier	AMD Fairchild National

Amplifiers (cont)

Device	M38510/	Description	Source
741	10101	Operational Amplifier	AMD Fairchild Intersil
747	10102	Dual Operational Amplifier	AMD Fairchild National

COMPARATORS

710	10301	Voltage Comparator	Fairchild

VOLTAGE REGULATORS

723	10201	Voltage Regulator	Fairchild

Memory

PROM

HPROM0512	20101	512-Bit Programmable Read Only Memory	Harris

SHIFT REGISTERS

4006	05701	18-Bit Static S.R.	National RCA
4014	05702	8-Bit Static S.R. (Synchronous)	National RCA
4015	05703	Dual 4-Bit Static S.R.	National RCA
4021	05704	8-Bit Static S.R. (Asynchronous)	National RCA
4031	05705	64-Bit Static S.R.	National RCA
54L95	02801	4-Bit Parallel Access S.R.	National
5495	00901	4-Bit Parallel Access S.R.	Motorola Signetics
5496	00902	5-Bit S.R.	Motorola Signetics
54164	00903	8-Bit Serial-In Parallel-Out S.R.	Signetics
54165	00904	8-Bit Parallel-Serial S.R.	Motorola
54194	00905	4-Bit Universal S.R.	Motorola
54195	00906	4-Bit Parallel Access S.R.	Motorola

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MASTER SELECTION GUIDE

The Master Selection Guide is the most comprehensive directory of integrated circuitry available in the United States. It organizes them into categories — digital, interface, linear, memory and microprocessor. Within these categories it classifies the devices by type (i.e., CMOS, ECL, TTC, etc.) and by function (counters, gates, flip-flops, etc.). Furthermore, the guide includes detailed data provided by the manufacturers for those products which they have chosen as particularly important.

how to use the master selection guide

This guide provides sufficient information to make initial product selections, to lead you to a group of device numbers and manufacturers' names. It enables you to find the products which are most apt to fulfill your major requirements and then provides data to help you make your final choice. All devices that appear in this selection, both in the initial selection guide and in the data pages, are included in the Part Number and Product Indexes. These index listings lead to the page and the line on that page where each device appears. Users of the 1976 IC Master will find several new features in the 1977 selection guide. These include an alphabetized topic index which starts on the next page. The coverage of industrial and consumer circuits has been greatly expanded; the guide now identifies these products by model number and covers digital, linear and digital-linear combinations under one heading, Linear & Consumer Circuits. The TTL major families, TTL, TTL-LS, TTL-H and TTL-S have been combined under one heading to facilitate function comparisons. And the Microprocessor section has been enlarged, grouping microprocessor system components together by processor type and adding many new system descriptions.

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Function	Section
A	
AC Detector	Linear—Other Devices
Active Filter	Linear—Other Devices
Active Terminator	Digital—ECL 10000, Miscellaneous
Adders	Digital—CMOS, Arithmetic Functions
	Digital—ECL 10000, Arithmetic Functions
	Digital—TTL, Arithmetic Functions
	Digital—Special
Address Latch Element	Microprocessors—System Components
Alarm Circuits	Linear—Other Devices
Amplifier/Detector FM IF	Linear—Consumer Circuits
Amplifiers	
AC	Linear—Other Devices
	Linear—Special Purpose
AGC/Squelch	Linear—Amplifiers, Special Purpose
	Linear—Consumer Circuits
AM/FM IF	Linear—Consumer Circuits
AM/FM IF and AF	Linear—Consumer Circuits
Audio, Power	Linear—Consumer Circuits
Current	Linear—Amplifiers, Special Purpose
Differential/ Cascade	Linear—Amplifiers, Special Purpose
Differential Input/ Output	Linear—Amplifiers, Special Purpose
Followers	Linear—Followers
Hearing Aid	Linear—Consumer Circuits
Instrumentation	Linear—Amplifiers, Special Purpose
	Linear—Operational Amplifier Characteristics
Isolation	Linear—Amplifiers, Special Purpose
Limiting	Linear—Amplifiers, Special Purpose
Log/Antilog	Linear—Amplifiers, Special Purpose
Microphone	Linear—Amplifiers, Special Purpose
Mixer/RF	Linear—Consumer Circuits
Operational	Linear—Operational Amplifier Characteristics
	Linear—Operational Amplifiers, General Purpose
	Linear—Operational Amplifiers, High Output Current
	Linear—Operational Amplifiers, High Speed
	Linear—Operational Amplifiers, High Voltage
	Linear—Operational Amplifiers, Low Bias Current
	Linear—Operational Amplifiers, Low Drift
	Linear—Operational Amplifiers, Programmable
	Linear—Operational Amplifiers, Single Supply
	Linear—Operational Amplifiers, Wide Band
Preamplifier	Linear—Amplifiers, Special Purpose
	Linear—Consumer Circuits
RF	Linear—Amplifiers, Special Purpose
RF Detector/Video	Linear—Consumer Circuits
Sense	Interface—Sense Amplifiers
Single Ended Input/Output	Linear—Amplifiers, Special Purpose
Transconductance	Linear—Amplifiers, Special Purpose
Video, IF and RF	Linear—Amplifiers, Special Purpose
Wideband	Linear—Amplifiers, Special Purpose
Analog Memories	Linear—Other Devices
Analog Switches	Interface—Analog Switches
Arithmetic Logic Element	Digital—TTL, Arithmetic Functions
Arithmetic Logic Register Stack	Digital—CMOS, Arithmetic Functions
	Microprocessors—System Components
Arithmetic Logic Unit	Microprocessors—System Components
	Digital—CMOS, Arithmetic Functions
	Digital—ECL 10000, Arithmetic Functions
	Digital—ECL 100K, Arithmetic Functions
	Digital—TTL, Arithmetic Functions
Arrays	
Bipolar	Linear—Arrays
CMOS	Linear—Arrays, Special Arrays
Custom	Digital—Special
	Linear—Other Devices
Thyristor/ Transistor	Linear—Arrays, Special Arrays
Transistor	Linear—Arrays, Transistor Arrays
Transistor/Diode	Linear—Arrays, Special Arrays
Asychronous Communication Controller	Microprocessors—System Components
Audio Noise Reduction Dolby	Linear—Consumer Circuits
B	
Bandpass Filters	Linear—Telecommunication Circuits
Baseband Channel Amplifier	Linear—Telecommunication Circuits
Baud Rate Generator	Digital—Special
	Interface—Serial Transmitters, Receivers
Bidirectional Bus Driver	Microprocessor—System Components
Bidirectional Port	Microprocessor—System Components
Bidirectional Transceiver	Interface—Line Circuits, Line Transceivers
	Microprocessor—System Components
Bit Rate Generator	Digital—CMOS, Miscellaneous
	Microprocessors—System Components
Bucket Brigade Device	Linear—Other Circuits
Buffers	Digital—CMOS, Buffers/Inverters
	Digital—ECL 10000, Buffers
	Digital—HNIL/HTL, Buffers/Inverters
	Digital—TTL, Buffers/Inverters
	Digital—TTL, Drivers
	Microprocessors—System Components
Bus Interface Circuits	Interface—Line Circuits
	Microprocessors—System Components
Bus Receiver	Digital—ECL 10000, Miscellaneous
	Interface—Line Circuits
Bus Switch	Digital—TTL, Miscellaneous
Bus Transceiver	Digital—ECL 10000, Miscellaneous
	Digital—TTL, Miscellaneous
	Interface—Line Circuits
	Microprocessor—System Components
C	
Calculator Circuits	Linear—Consumer Circuits
Calculator, Display Interface	Linear—Consumer Circuits
Calculator, Keyboard Entry Sequence Memory	Linear—Consumer Circuits
Calculator, Printing	Linear—Consumer Circuits
Camera Exposure Control	Linear—Consumer Circuits
Cassette Controller	Microprocessor—System Components
CCD Memories	Memories—RAMs, CCD Memories
Central Processing Unit	Microprocessors—System Components
Character Generators	Memory—Character Generators
Clock	Digital—CMOS, Oscillators/Dividers
	Linear—Consumer Circuits
Clock Buffer	Interface—Memory and Peripheral Drivers
	Microprocessors—System Components
Clock Generator	Microprocessors—System Components
Code Converters	Memory—Code Converters

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Function	Section
Coin Box Circuits	Linear—Telecommunication Circuits
Compander	Linear—Telecommunication Circuits
Comparators, Digital	Digital—CMOS, Arithmetic Functions
	Digital—ECL 10000, Arithmetic Functions
	Digital—ECL III, Arithmetic Functions
	Digital—HNIL/HTL, Arithmetic Functions
	Digital—TTL, Arithmetic Functions
Comparators, Linear	Linear—Comparators, Single Comparators
	Linear—Comparators,Dual Comparators
	Linear—Comparators, Quad Comparators
	Linear—Phase Locked Loop Circuits
Compressor (Compander)	Linear—Telecommunication Circuits
Contact Bounce Eliminator	Digital—CMOS, Miscellaneous
	Digital—TTL, Miscellaneous
Control Element	Microprocessors—System Components
Control ROM	Microprocessors—System Components
Control Sequencer	Microprocessors—System Components
Converters	
Analog to Digital	Interface—Analog to Digital Converters, Binary Output
	Interface—Analog to Digital Converters, Decimal Output
	Linear—Other Devices
BCD to Binary	Digital—TTL, Miscellaneous
Binary to Phone Pulse	Digital—CMOS, Miscellaneous
Digital to Analog	Interface—Digital to Analog Converters
Voltage to Frequency	Linear—Other Devices
Correlation	Digital—Special
Counters	Digital—CMOS, Counters
	Digital—ECL III, Counters
	Digital—HNIL/HTL, Counters
	Digital—TTL, Counters
	Digital—Special
Binary	Digital—CMOS, Counters, Binary
	Digital—ECL 10000, Counters, Binary
	Digital—ECL 95000, Counters
	Digital—ECL III, Counters
	Digital—HNIL/HTL, Counters
	Digital—TTL, Binary Counters Up
	Digital—TTL, Binary Counters Up/Down
	Digital—Special
Decade	Digital—CMOS, Counters, Decade
	Digital—ECL 10000, Counters, Decade
	Digital—ECL 95000, Counters
	Digital—ECL III, Counters
	Digital—HNIL/HTL, Counters
	Digital—TTL, Decade Counters Up
	Digital—TTL, Decade Counters Up/Down
	Digital—TTL, Miscellaneous
	Digital—Special
Counter Time Base	Digital—Special
Counting Register	Digital—ECL 100K, Counters
CRC Generator/ Checker	Interface—Error Checking Circuits
	Microprocessor—System Components

D

Data Access Register	Digital—CMOS, Arithmetic Functions
	Microprocessors—System Components
Data Path Switch	Digital—CMOS, Arithmetic Functions
	Linear—Analog Switches
	Microprocessors—System Components
Data Selector/ Multiplexer	Linear—Analog Switches, Multiplexers
	Microprocessors—System Components
Decoders	Digital—CMOS, Decoders
	Digital—ECL 10000, Decoders
	Digital—ECL 100K, Decoders
	Digital—TTL, Decoders
	Digital—CMOS, Drivers
	Digital—Special
	Interface—Display Drivers
	Microprocessors—System Components
FM Stereo	Linear—Consumer Circuits
Keyboard	Interface—Keyboard Encoders, Decoders
Tone	Linear—Phase Locked Loop Circuits
	Linear—Telecommunication Circuits
Delta Modulation System	Linear—Telecommunication Circuits
Deskew FIFO	Memory—FIFO
	Microprocessors—General Purpose
Dialer Circuits	Linear—Telecommunication Circuits
Digital Filter Switch	Linear—Telecommunication Circuits
Digital Mixer	Linear—Phase Locked Loop Circuits
Digital to Analog Converters	Interface—Digital to Analog Converters
Diode Matrix, Programmable	Digital—Special
Direct Memory Access	Microprocessors—System Components
Display Controller	Microprocessors—System Components
Display Drivers	Interface—Display Drivers
Dividers	Digital—Special
	Digital—CMOS, Oscillators/Dividers
	Digital—TTL, Miscellaneous
	Linear—Phase Locked Loop Circuits
	Linear—Other Devices
Double Balanced Mixer	Linear—Phase Locked Loop Circuits
DPDT Switches	Interface—Analog Switches
DPST Switches	Interface—Analog Switches
Drivers	Digital—CMOS, Drivers
	Digital—CMOS, Miscellaneous
	Digital—ECL 10000, Drivers
	Digital—ECL 100K, Drivers
	Digital—HNIL/HTL, Drivers
	Digital—TTL, Decoders
	Digital—TTL, Drivers
	Digital—TTL, Miscellaneous
	Interface—Display Drivers
	Interface—Line Circuits
	Interface—Memory and Peripheral Drivers
Audio	Linear—Consumer Circuits
Counter Display	Digital—Special
DVMs	Digital—Special
	Interface—Analog to Digital Converters, Decimal Output
Dynamic Memory Interface	Interface—Memory and Peripheral Drivers
	Microprocessors—System Components
Dynamic Memory Refresh Controller	Interface—Memory and Peripheral Drivers
	Microprocessors—System Components

E

Encoders	Digital—CMOS, Miscellaneous
	Digital—ECL 10000, Miscellaneous
	Digital—ECL 100K, Miscellaneous
	Digital—TTL, Miscellaneous
	Digital—Special
Keyboard	Interface—Keyboard Encoder-Decoders
Error Checking Circuits	Interface—Error Checking Circuits
Expander (Compander)	Digital—TTL, Miscellaneous
	Linear—Telecommunication Circuits

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Function	Section
F	
Field Programmable Logic Array	Memory—PLAs
	Microprocessors—System Components
First In First Out Memory	Memory—FIFO
	Microprocessors—System Components
Flasher	Linear—Other Devices
Flip-Flops	Digital—CMOS, Flip-Flops
	Digital—ECL 10000, Flip-Flops
	Digital—ECL 95000, Flip-Flops
	Digital—ECL 100K, Flip Flops
	Digital—ECL III, Flip-Flops
	Digital—HNIL/HTL, Flip-Flops
	Digital—TTL, Flip-Flops
	Digital—Special
Floppy Disc Controller	Microprocessors—System Components
FM Muting/Tuning Point System	Linear—Consumer Circuits
FM RF/IF Amplifier	Linear—Consumer Circuits
Followers	Linear—Followers
Four Channel Sound	Linear—Consumer Circuits
Frequency Sensitive Switch	Linear—Telecommunication Circuits
Frequency to Voltage Converter	Linear—Other Devices
FSK Modulator/ Demodulator	Linear—Phase Locked Loop Circuits
G	
Games, T.V.	Linear—Consumer Circuits
Gates	Digital—CMOS, Gates, Miscellaneous
	Digital—HNIL/HTL, Gates, Miscellaneous
	Digital—TTL, Gates, Miscellaneous
AND/NAND	Digital—CMOS, Gates, AND/NAND
	Digital—ECL 10000, Gates, AND/NAND
	Digital—HNIL/HTL, Gates, AND/NAND
	Digital—TTL, Gates, AND/NAND
AND-OR/AND-OR Invert	Digital—CMOS, Gates, AND-OR/ AND-OR Invert
	Digital—ECL 10000, Gates, AND-OR/ AND-OR Invert
	Digital—ECL 100K, Gates, AND-OR/ AND-OR Invert
	Digital—HNIL/HTL, Gates, AND-OR/ AND-OR invert
	Digital—TTL, Gates, AND-OR/ AND-OR Invert
Exclusive OR/NOR	Digital—CMOS, Gates, Exclusive OR/NOR
	Digital—ECL 10000, Gates, Exclusive OR/NOR
	Digital—ECL 100K, Gates, Exclusive OR/NOR
	Digital—ECL III, Gates, Exclusive OR/NOR
	Digital—HNIL/HTL, Gates, Exclusive OR/NOR
	Digital—TTL, Gates, Exclusive OR/NOR
Majority Logic	Digital—CMOS, Gates, Miscellaneous
	Digital—TTL, Gates, Miscellaneous
OR/NOR	Digital—CMOS, Gates, OR/NOR
	Digital—ECL 10000, Gates, OR/NOR
	Digital—ECL 95000, Gates, OR/NOR
	Digital—ECL 100K, Gates, OR/NOR
	Digital—ECL III, Gates, OR/NOR
	Digital—TTL, Gates, OR/NOR
	Digital—Special
Gate Expander	Digital—HNIL/HTL, Gates, Miscellaneous
General Interface Circuit	Microprocessors—System Components
General Purpose Input/Output	Microprocessors—System Components
Ground Fault Interrupter	Linear—Consumer Circuits
H	
Hall Effect Devices	Digital—Special
	Linear—Other Devices
Hamming Code Detector and Generator	Digital—TTL, Miscellaneous
	Interface—Error Checking Circuits
I	
Identity Comparator	Digital—TTL, Arithmetic Functions
Image Sensor	Linear—Other Devices
Input/Output Control Unit	Microprocessors—System Components
Interface Latch Element	Microprocessors—System Components
Interrupt Control Unit	Microprocessors—System Components
Interrupter, Ground Fault	Linear—Consumer Circuits
Interval Timer	Linear—Timers
	Microprocessors—System Components
Inverters	Digital—CMOS, Buffers/Inverters
	Digital—HNIL/HTL, Buffers/Inverters
	Digital—HNIL/HTL, Gates, Miscellaneous
	Digital—TTL, Buffers/Inverters
K	
Keyboard Encoders	Interface—Keyboard Encoders, Decoders
L	
Last In First Out Memory	Memory—LIFOs
Latches	Digital—CMOS, Latches
	Digital—ECL 10000, Latches
	Digital—ECL 95000, Latches
	Digital—ECL 100K, Latches
	Digital—ECL III, Latches
	Digital—HNIL/HTL, Latches
	Digital—TTL, Latches
	Microprocessors—System Components
Level Detector	Linear—Other Devices
Light Activated Switch	Linear—Other Devices
Light Detector	Linear—Other Devices
Line Drivers	Interface—Line Circuits, Single Ended
	Interface—Line Circuits, Differential
Line Receivers	Digital—ECL 10000, Miscellaneous
	Digital—ECL 100K, Miscellaneous
	Digital—ECL III, Miscellaneous
	Interface—Line Circuits, Single Ended
	Interface—Line Circuits, Differential
Line Transceiver	Interface—Line Circuits, Single Ended
	Interface—Line Circuits, Differential
Logic Processor	Microprocessors—System Components
Look Ahead Carry Generator	Digital—CMOS, Arithmetic Functions
	Digital—ECL 10000, Arithmetic Functions
	Digital—TTL, Arithmetic Functions
	Microprocessor—System Components
Low Battery Indicator	Linear—Other Devices
M	
Memories	
Active Element	Digital—TTL, Memories
CAM	Digital—CMOS, Memories
	Digital—TTL, Memories
Character Generators	Memory—Character Generators
Code Converters	Memory—Code Converters

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Function	Section
FIFO	Digital—CMOS, Memories
	Digital—TTL, Memories
	Memory—FIFO
LIFO	Digital—CMOS, Memories
	Memory—LIFO
PLA	Memory—PLAs
PROM	Digital—ECL 10000, Memories
	Memory—PROMs
	Microprocessors—System Components
RAM	Digital—CMOS, Memories
	Digital—ECL 10000, Memories
	Digital—ECL 95000, Memories
	Digital—ECL 100K, Memories
	Digital—TTL, Memories
	Memory—RAMs, Dynamic
	Memory—RAMs, CCD Memories
	Memory—RAMs, Static
	Microprocessors—System Components
ROM	Digital—CMOS, Memories
	Memory—EAROMs
	Memory—ROMs, Static
	Memory—ROMs, Dynamic
	Microprocessors—System Components
Memory Control Unit	Microprocessors—System Components
Memory Drivers	Interface—Memory and Peripheral Drivers
Memory Interface	Interface—Memory and Peripheral Drivers
	Microprocessors—System Components
Memory Refresh Logic Circuits	Digital—TTL, Miscellaneous
	Interface—Memory and Peripheral Drivers
Micro Address Generator	Digital—TTL, Miscellaneous
MICROM	Microprocessors—System Components
Micro Computer	Microprocessors—System Components
Micro Controller	Digital—TTL, Arithmetic Functions
	Microprocessors—System Components
Microprocessor	Digital—TTL, Arithmetic Functions
	Microprocessors—Selection Tables
	Microprocessors—System Components
Microprogram Control Unit	Microprocessor—System Components
Microprogram Sequencer	Digital—TTL, Miscellaneous
	Microprocessor—System Components
Mixer	Linear—Amplifiers, Special
Modem	Digital—CMOS, Miscellaneous
	Linear—Telecommunication Circuits
	Linear—Other Devices
	Microprocessors—System Components
Modulator	Linear—Other Devices
	Linear—Consumer Circuits
Motor Speed Regulator	Linear—Other Devices
Multiplexers	
Analog	Interface—Analog Switches, Multiplexers
Digital	Digital—CMOS, Multiplexers
	Digital—ECL 10000, Multiplexers
	Digital—ECL 100K, Multiplexers
	Digital—HNIL/HTL, Multiplexers
	Digital—TTL, Multiplexers
Multipliers	Digital—ECL 10000, Arithmetic Functions
	Digital—TTL, Arithmetic Functions
	Microprocessors—System Components
	Linear—Other Devices
Binary	Digital—CMOS, Arithmetic Functions
Binary Rate	Digital—CMOS, Miscellaneous
	Digital—TTL, Miscellaneous
Decade Rate	Digital—TTL, Miscellaneous
Multipliers/Dividers	Linear—Other Devices
	Microprocessors—System Components

Function	Section
Multivibrators	Digital—CMOS, Multivibrators
	Digital—ECL III, Multivibrators
	Digital—HNIL/HTL, Multivibrators
	Digital—TTL, Multivibrators
	Digital—Special
Monostable/ Astable	Digital—CMOS, Multivibrators
	Digital—ECL 10000, Multivibrators
	Digital—ECL 100K, Multivibrators
	Digital—HNIL/HTL, Multivibrators
	Digital—TTL, Multivibrators
Music Circuits	Linear—Consumer, Organ Circuits
N	
Nines Complementer	Digital—CMOS, Arithmetic Functions
O	
Organ Circuits	Linear—Consumer Circuits
Oscillators	Digital—CMOS, Oscillators/Dividers
	Linear—Phase Locked Loop Circuits
P	
Parallel Data Controller	Microprocessors—System Components
Parallel Interface Element	Microprocessors—System Components
Parity Generator	Digital—CMOS, Miscellaneous
	Digital—ECL 10000, Miscellaneous
	Digital—ECL 100K, Miscellaneous
	Digital—TTL, Miscellaneous
	Interface—Error Checking Circuits
Parity Tree	Digital—CMOS, Miscellaneous
	Digital—TTL, Miscellaneous
Peripheral Drivers	Interface—Memory and Peripheral Drivers
Peripheral Input/Output	Microprocessrs—System Components
Peripheral Interface Adapter	Microprocessors—System Components
Phase Comparator	Digital—CMOS, Miscellaneous
	Interface—Phase Locked Loop Circuits
Phase Frequency Detector	Digital—TTL, Miscellaneous
	Linear—Phase Locked Loop Circuits
Phase Locked Loop Circuits	Digital—CMOS, Miscellaneous
	Linear—Phase Locked Loop Circuits
Stereo Decoders	Linear—Consumer Circuits
Polynomial Generator	Digital—TTL, Miscellaneous
	Interface—Error Checking Circuits
Preamplifier	Linear—Amplifiers, Special
Audio	Linear—Consumer Circuits
Prescalers	Digital—Special
	Linear—Phase Locked Loop Circuits
Printer Controller	Microprocessors—System Components
Printer Interface	Microprocessors—System Components
Priority Encoder	Digital—CMOS, Miscellaneous
Priority Interrupt	Microprocessors—System Components
Processing and Control Element	Microprocessors—System Components
Programmable CRT Controller	Microprocessors—System Components
Programmable General Purpose I/O	Microprocessors—System Components
Programmable Interface Controller	Microprocessors—System Components
Programmable Keyboard/Display Device	Interface—Keyboard Encoders
	Microprocessors—System Components

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Function	Section
Programmable Logic Arrays	Digital—CMOS, Miscellaneous Digital—TTL, Miscellaneous Memory—PLAs
Programmable Systems Interface	Microprocessors—System Components
Program Memory	Microprocessors—System Components
Program Stack	Microprocessors—System Components
Program Storage Unit	Microprocessors—System Components
PROMS	Memory—PROMs
Pulse Stretcher	Digital—HNIL/HTL, Miscellaneous
Q	
Quad Power Strobe	Digital—TTL, Miscellaneous
R	
Radio Transmitter	Linear—Other Devices
RAM Interface	Interface—Memory and Peripheral Interface Microprocessors—System Components
RAMS	Memory—RAMs
Read Amplifier/ Preamplifier	Linear—Amplifiers, Special Purpose
Receiver AM	Linear—Consumer Circuits
Receiver AM/FM	Linear—Consumer Circuits
Register File	Digital—TTL, Memories
Regulator, Motor Speed	Linear—Consumer Circuits
Regulator, Switching	Linear—Other Linear Devices
Regulator, Voltage	Linear—Voltage Regulators
Relay Driver	Linear—Consumer Circuits
Remote Control Circuits	Linear—Consumer Circuits, T.V. Remote Control
RMS Converter	Linear—Other Devices
ROMS	Memory—ROMs
S	
Sample and Hold Circuits	Linear—Other Devices
Sense Amplifiers	Interface—Sense Amplifiers
Sequence Controller	Microprocessors—System Components
Serial Receiver	Interface—Serial Transmitters-Receivers
Serial Transmitter	Interface—Serial Transmitters-Receivers
Serial Data Controller	Microprocessors—System Components
Servo Driver	Linear—Consumer Circuits
Shift Registers	Digital—CMOS, Shift Registers Digital—ECL 10000, Shift Registers Digital—ECL 95000, Shift Registers Digital—ECL 100K, Shift Registers Digital—ECL III, Shift Registers Digital—HNIL/HTL, Shift Registers Digital—TTL, Shift Registers Memory—Shift Registers, Dynamic Memory—Shift Registers, Static
Schmitt Trigger	Digital—CMOS, Miscellaneous Digital—HNIL/HTL, Miscellaneous Digital—TTL, Miscellaneous Digital—Special
Sine Wave Generator	Linear—Other Devices
Smoke Detector	Linear—Other Devices
Sonar Transceiver	Linear—Consumer Circuits Linear—Other Devices
Speedometer Circuit	Linear—Consumer Circuits
SPDT Switches	Interface—Analog Switches
SPST Switches	Interface—Analog Switches
SSB Detector	Linear—Consumer Circuits
Static Memory Interface	Microprocessors—System Components
Successive Approximation Register	Digital—CMOS, Miscellaneous Digital—TTL, Miscellaneous
Switches	Linear—Consumer Circuits
Analog	Interface—Analog Switches
Crosspoint	Interface—Analog Switches, Multiplexers
Drivers	Interface—Analog Switches, Drivers
Synchronous Communications Controller	Microprocessors—System Components
Synchronous Serial Data Adapter	Microprocessors—System Components
Synthesizer	Linear—Phase Locked Loop Circuits
System Controller and Bus Driver	Microprocessors—System Components
T	
Tachometer	Linear—Consumer Circuits
Telecommunications Data Interface	Microprocessors—System Components
Telephone Circuits	Linear—Telecommunication Circuits
Temperature Transducers	Linear—Other Devices
Threshold Switch	Linear—Other Devices
Timers	Digital—CMOS, Miscellaneous Linear—Consumer Circuits Linear—Timers
Timing Function	Microprocessors—System Components
Tone Decoder	Linear—Phase Locked Loop Circuits
Tone Operated Switch	Linear—Telecommunication Circuits
Tone Receiver	Linear—Telecommunication Circuits
Tone Transmitter	Linear—Telecommunication Circuits
Translators	Digital—CMOS, Translators Digital—ECL 10000, Translators Digital—ECL 95000, Translators Digital—HNIL/HTL, Translators Digital—TTL, Translators
Transmitter	Linear—Consumer Circuits
T.V. Circuits	Linear—Consumer Circuits
U	
UART	Interface—Serial Transmitters-Receivers
V	
Video Tape Recorder	Linear—Consumer Circuits
Voltage Controlled Oscillators	Digital—ECL III, Miscellaneous Digital—TTL, Miscellaneous Linear—Consumer Circuits Linear—Phase Lock Loop Circuits
Voltage Detector	Linear—Other Devices
Voltage Reference Source	Linear—Other Devices
Voltage Regulators	Linear—Voltage Regulators, Fixed Positive Fixed Negative Fixed Dual Adjustable Positive Adjustable Negative Adjustable Dual
Automotive	Linear—Consumer Circuits
W/Z	
Watch Circuits	Digital—CMOS, Oscillators/Dividers Linear—Consumer Circuits
Zero Voltage and Zero Crossing Triggers	Linear—Other Devices

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ABBREVIATIONS OF COMPANY NAMES

AD	Analog Devices
AMD	Advanced Micro Devices
AMI	American Microsystems, Inc.
AMS	Advanced Memory Systems (Intersil)
Analogic	Analogic Corp.
Beckman	Beckman Instruments, Helipot Division
Burr-Brown	Burr-Brown Research
Cermetek	Cermetek
CMA	Consumer Microcircuits of America
Collins	Collins, Rockwell International
Data Gen	Data General
Datel	Datel Systems
DDC	Data Devices Corp.
EA	Electronic Arrays
EMM/Semi	EMM Semi, Div. of Electronic Memories & Magnetics
Essex	Essex International
Exar	Exar Integrated Systems
Fairchild	Fairchild Semiconductor Systems
Ferranti	Ferranti Electric
Fujitsu	Fujitsu
GI	General Instrument
Harris	Harris Semiconductor
Hitachi	Hitachi America, Ltd.
Hughes	Hughes Aircraft, MOS Division
Hybrid Sys	Hybrid Systems
IMI	International Microcircuits, Inc.
Intech	Intech/Function Modules
Intel	Intel
Interdesign	Interdesign
Intersil	Intersil
IPI	Integrated Photomatrix, Inc.
ITT	ITT Semiconductors
Lithic Sys	Lithic Systems
Litronix	Litronix
LSI Comp	LSI Computer Systems
Micro Comp	Micro Components
Micro Net	Micro Networks
Micropac	Micropac Industries
Micro Power	Micro Power Systems
Mitel	Mitel Semiconductor
Mitsubishi	Mitsubishi International
MMI	Monolithic Memories, Inc.
MOS	MOS Technology
Mostek	Mostek
Motorola	Motorola Semiconductor
National	National Semiconductor
NCR	National Cash Register, Microelectronics Div.
NEC	NEC Microcomputers
Nippon	Nippon Electric Co.
Nitron	Nitron
Nortec	Nortec Electronics
NPC	Nucleonic Products Co.
Panasonic	Panasonic, Matsushita Electric Corp.
Plessey	Plessey Semiconductors
PMC	Power Monolithics Co.
PMI	Precision Monolithics, Inc.
Ragen	Ragen Semiconductor
Raytheon	Raytheon Semiconductor
RCA	RCA Solid State Division
Reticon	Reticon
Rockwell	Rockwell, Microelectronic Div.
Sanken	Sanken Electric
SGS	SGS-ATES Semiconductor
Siemens	Siemens
Signetics	Signetics
Silicon G	Silicon General
Siliconix	Siliconix
SMC	SMC Microsystems Corp.
SMS	Scientific Micro
Solitron	Solitron Devices
Sprague	Sprague Electric Company
SSS	Solid State Scientific
SW	Stewart-Warner Microcircuits
Synertek	Synertek
Teledyne C	Teledyne Crystalonics
Teledyne P	Teledyne Philbrick
Teledyne S	Teledyne Semiconductor
Telefunken	AEG-Telefunken
TI	Texas Instruments
TMX	TMX
Toshiba	Toshiba
TRW	TRW
Western	Western Digital
Zilog	Zilog

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INTRODUCTION TO DIGITAL

The Master Selection Guide provides sufficient information to make initial product selections, to lead you to a group of device numbers and manufacturers' names. It enables you to find the products which are most appropriate to fulfill your major requirements and then provides data for many of the more important products.

All devices that appear in this section, both in the initial selection guide and in the data pages, are included in the Part Number and Product Indexes. These index listings lead to the page and the line on that page where each device appears.

The first two pages of the digital section present comparisons of the performance of the major digital families to help you choose between families. These are followed by lists of the devices in each family arranged into functional groups (arithmetic, buffers/inverters, etc.). Within each group you can readily determine all of the various circuits available, surveying the entire IC industry so that you know all your options. The initial selection lists are followed by the device data pages which have been provided for you by the manufacturers. When such data is in the book, the page numbers are given with the initial selection listings.

Some digital circuits — calculator, watch chips, and electronic organ circuits — are not included in this section, but they are covered in detail in the new Linear-Consumer section. Digital circuits which do not fall into one of the major logic families are listed at the end of the selection information under the heading Digital-Other Devices.

This section is not complicated by reference to package styles; the package style suffixes are usually deleted. For more information on each companies' suffixes, see the Part Number Guide.

Throughout the Master Selection Guide, each full military temperature range (−55°C to 125°C) device is indicated by a dagger (†) before the manufacturer's name. Manufacturers' names are normally spelled out; however, a few are abbreviated and the abbreviations are explained on page 144.

Page Number Index — Digital Devices

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Detailed Product Information provided by:

American Microsystems Inc. 206
Harris Semiconductor 207
Raytheon Semiconductor 209

The manufacturers listed above are providing detailed information on their latest and most significant products. They have made this investment to help you. Some chose not to.
If you want to see more data in future editions, tell the manufacturers through their salesmen and distributors.

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WHICH DIGITAL FAMILY?

Edited from material published in Fairchild Progress magazine, Peter Alfke, author.

With several digital families available, the logical question is — which are the best ICs for my particular application?

To answer the question, you need to evaluate the pros and cons of the various logic families. These tradeoffs are listed in Tables I-IV. You will need to establish your speed requirements. Since speeds are characterized by the clock rate of registers and counters, this discussion is divided into four groups based on clock rates.

Very High Speed	Clock Rate	> 100 MHz	ECL
High Speed	Clock Rate	30 to 100 MHz	ECL, S-TTL
Medium Speed	Clock Rate	5 to 50 MHz	LS-TTL, TTL
Low Speed	Clock Rate	< 5 MHz	LS-TTL, CMOS

VERY HIGH SPEED SYSTEMS — Clock Rate > 100 MHz

There is only one reasonable IC logic family for use in very high speed systems — Emitter Coupled Logic, ECL. Originally, this technology presented considerable electrical problems such as voltage and temperature sensitivity and fast edge rates that caused reflection and cross-talk problems. In recent years, however, ECL development has become more user-oriented and there is better compatibility between circuit characteristics and interconnection techniques.

The modern popular ECL line is the 10,000 Series, manufactured in uncompensated, in voltage-compensated, or in both voltage and temperature-compensated forms. The latter form of compensation assures that significant parameters such as logic levels, noise margins and speed remain constant over a wide range of temperature and power supply voltage. These 10K and 95K logic circuits have deliberately slowed-down edge rates to make them easier to use and they can also drive terminated transmission lines whenever required by the interconnection length.

HIGH SPEED SYSTEMS — Clock Rate 30 to 100 MHz (Table II)

Here, you have a choice between ECL and Schottky TTL. H-TTL is really obsolete since it consumes more power than Schottky TTL, has similar interconnection problems and offers only half the speed. Also, it is not significantly faster than the best Low Power Schottky TTL. So, this narrows down your choice to ECL and Schottky TTL.

MEDIUM SPEED SYSTEMS — Clock Rate 5 to 50 MHz (Table III)

Standard TTL has been the obvious choice for medium speed systems for many years. Many designs will increasingly use Low Power Schottky TTL as it becomes more available, multiple sourced, and as the price premium decreases. You can mix standard and LS-TTL to solve most fan-out problems.

SLOW SPEED SYSTEMS — Clock Rate < 5 MHz (Table IV)

If you design slow speed systems you are faced with the largest number of attractive alternatives. Traditionally, TTL and DTL has been used. Now you can save power, cost and avoid heat and reliability problems by changing to LS-TTL, without affecting the logic design and perhaps not even changing the PC board layout.

If the system speed permits, you can switch to CMOS and save even more power and simplify the power supply, but now you must cope with a family of different logic elements and a hodgepodge of MSI elements, far less systems oriented than the better TTL circuits. Also you will notice wide parameter differences between the "same" products from different vendors.

The greatest challenge, however, is to examine the traditional hard-wired system design and decide whether or not it can be implemented with a microprocessor. If the requirements are both complicated and slow enough, this approach might save manufacturing cost, design time, and service time, as well as improve reliability, provide additional flexibility, and perhaps allow additional features at no extra cost.

MOS (p-channel, n-channel, either metal or silicon gate, also silicon on sapphire) does not compete directly with LS-TTL and CMOS. The MOS logic elements (gates and flip-flops) are very small but the input and output buffers are so large and relatively slow that MOS cannot be cost/performance competitive at MSI complexity (below 200 gates). MOS is therefore meaningful only in LSI circuits, where it has proven to be not only competitive, but dominating. These areas are:

- LSI memories, RAMs, ROMs, and shift registers of 500 to 4096 bits at clock rates below 5 MHz.
- Specialized, inherently slow LSI functions produced in very large volume (calculators, clocks, some instrument circuits like DVMs).
- Custom LSI circuits where the manufacturing volume is high enough or the weight/space saving valuable enough to absorb the development cost.
- Microprocessors, where a very carefully designed, standard circuit performs specialized tasks through ROM-stored programming.

SUMMARY

The proliferation of digital circuits and technologies gives you a new degree of freedom, but it also challenges your judgement and imagination. You are faced with an almost overwhelming number of competing technologies, each with its strong and weak points. The basic component speed requirement and the available power will quickly narrow your choice down to two or three different logic families; the tables presented here will make your final decision easier.

You should not forget, however, that the component speed requirement is also affected by your choice of architecture. A parallel approach requires more, but slower components, while a serial architecture requires fewer but faster components. The vesatility of modern MSI circuits makes it easy to explore these alternatives. It is very important to choose the IC logic family at an early stage in the system design, since the full cost, speed and reliability advantages can only be gained by designing in accordance with the device features, taking advantage of their logic and organization.

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TABLE I: COMPARISON OF ELECTRICAL CHARACTERISTICS

	CMOS 5 V SUPPLY	CMOS 10 V SUPPLY	STANDARD TTL	74LS LOW POWER SCHOTTKY	9LS LOW POWER SCHOTTKY	SCHOTTKY TTL	10K ECL
PROPAGATION DELAY	35 ns	25 ns	10 ns	10 ns	5 ns	3 ns	2 ns
FLIP-FLOP TOGGLE FREQUENCY	5 MHz	10 MHz	35 MHz	40 MHz	80 MHz	100 MHz	200 MHz
QUIESCENT POWER[1]	10 nW	10 nW	10 mW	2 mW	2 mW	25 mW	25 mW
NOISE IMMUNITY	2 V	4 V	1 V	0.8 V	0.8 V	0.9 V	0.2 V
FAN OUT (within family)	> 50[2]	> 50[2]	10	20	20	10	> 50

[1]Note the change from nanowatts to milliwatts.
[2]Or as determined by allowable propagation delay.

TABLE II. COMPARISON OF DIGITAL LOGIC FAMILY CHARACTERISTICS FOR HIGH SPEED SYSTEMS (CLOCK RATE 30 TO 100 MHz)

10K AND 95K SERIES ECL	SCHOTTKY TTL
Advantages	**Disadvantages**
Short delays allow propagation through more logic levels in a clock cycle. Compatibility with even faster families currently in development makes future system upgrading easy.	Component delays are about twice as long as with ECL and will not be improved in the foreseeable future.
Low output impedance drives all types of interconnections including terminated transmission lines.	Outputs are not capable of driving terminated transmission lines without causing severe fan-out compromises.
High output drive capability and complementary outputs accommodate differential transmission over tested pairs.	
Slow edge rate minimizes reflection problems.	Has the fastest output transitions of any logic family, causing reflection problems even with relatively short interconnection lengths, and causing cross-talk problems.
Complementary outputs on many elements add design flexibility.	
Wired-OR capability simplifies logic design.	
Compensated circuits simplify power supply and temperature regulation.	Generates fast power supply load changes, requires good decoupling.
High input impedance minimizes loading, allows high fan-out.	Input thresholds and output low levels are slightly offset from conventional TTL, causing some loss of noise immunity.
Disadvantages	**Advantages**
Unfamiliar type of circuitry, logic, nomenclature, and pinouts.	Compatible with popular TTL, same supply voltage, almost identical signal levels, same SSI and MSI logic, nomenclature, pinouts. Ideal to speed up critical paths in standard TTL systems.
Not level-compatible with TTL and CMOS, requires additional interface elements.	
Requires external pull-down resistors on all used outputs.	Outputs require no pull-up (or down) resistors.
Has less absolute noise margin.	Large signal swing and large absolute noise immunity cause less problems with temperature or supply voltage variations and gradients, resistive drops along supply lines, and outside noise.
Higher ground current requires heavier distribution busses.	
Has one less logic pin per package due to double ground.	
Has higher power consumption at low frequencies than equivalent S-TTL circuits.	Has lower system power consumption at moderate speed.

TABLE III. COMPARISON OF DIGITAL LOGIC FAMILY CHARACTERISTICS FOR MEDIUM SPEED SYSTEMS (CLOCK RATE 5 TO 50 MHz)

STANDARD TTL	LOW POWER SCHOTTKY TTL
Advantages	**Disadvantages**
Large number of SSI and MSI functions.	Somewhat fewer devices but this is changing.
Low prices.	Presently higher priced than standard TTL.
Specifications standardized.	Electrical characteristics differ between suppliers.
Disadvantages	**Advantages**
High power consumption (10 mW per gate, 200 to 500 mW per MSI package.)	Saves 75% of the power of equivalent standard TTL.
Large, heavy, expensive, hot power supply and regulator.	Smaller, lighter, cheaper, cooler power supply and regulator.
Heat density problems when using predominantly MSI.	No heat density problem. Cooler, therefore more reliable.
	May eliminate the need for fans and filters.
Not fully compatible with most CMOS and MOS.	Compatible with CMOS and MOS.
	Generates less noise than standard TTL.

TABLE IV. COMPARISON OF DIGITAL LOGIC FAMILY CHARACTERISTICS FOR LOW SPEED SYSTEMS (CLOCK RATE 5 MHz)

STANDARD OR LOW POWER SCHOTTKY TTL	CMOS
Advantages	**Disadvantages**
Well designed, system-oriented MSI.	Some of the original CMOS circuits are poorly defined and not systems oriented.
Adequate speed, tight tolerances.	Low speed, delays depend on supply voltage and capacitive loading.
Low impedance outputs give good immunity against capacitively coupled noise.	Poor current noise immunity (capacitively coupled noise.)
Familiar functions, logic, pinouts.	New functions, logic pinouts.
Standard TTL available from many suppliers, low cost.	Large parameter variations between different vendors.
Disadvantages	**Advantages**
Relatively high static consumption and heat generation.	Extremely low static power consumption, very little heat generated at moderate speed.
Tight power supply voltage requirements (5 V ±5% commercial, ±10% military grade).	Very wide range of supply voltages (theoretically 3 . . . 20 V, practically 5 . . . 12 V).
Not well-suited for portable battery operation.	Ideally suited for battery operation.
More expensive power supply.	Low cost power supply. Less cost, weight, heat, size than for any other family.
Lower voltage noise immunity.	High voltage noise immunity, an advantage with inductively coupled noise.
LS-TTL available from only a few suppliers.	Available from many suppliers.

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DIGITAL—CMOS

Function	Device	Source	Line
Arithmetic Functions			
2 x 2 Bit (Parallel) Binary Multiplier	MC14554BA	† Motorola	
	MC14554BC	Motorola	
4-Bit Full Adder	F4008BC	Fairchild	
	F4008BM	† Fairchild	
	HD4008B-2	† Harris	
	HD4008B-9	Harris	
	HD54C83	† Harris	10
	HD74C83	Harris	
	MC14008BA	† Motorola	
	MC14008BC	Motorola	
	MM54C83	† National	
	MM74C83	National	
	CD4008BC	National	
	CD4008BM	† National	
	CD4008B	† RCA	
	CD4008BE	RCA	
	HBF4008AE	SGS	20
	SCL4008B	† SSS	
	SCL4008BE	SSS	
	CM4008A	† Solitron	
	CM4008AE	Solitron	
	TF4008A/B	† TI	
	TP4008A/B	TI	
	TC4008	Toshiba	
Triple Serial Adder (Positive Logic) with Internal Carry	MC14032BA	† Motorola	30
	MC14032BC	Motorola	
	CD4032B	† RCA	
	CD4032BE	RCA	
	CM4032A	† Solitron	
	CM4032AE	Solitron	
	TC4032	Toshiba	
Triple Serial Adder (Negative Logic) with Internal Carry	MC14038BA	† Motorola	
	MC14038BE	Motorola	40
	CD4038B	† RCA	
	CD4038BE	RCA	
	CM4038A	† Solitron	
	CM4038AE	Solitron	
	TC4038	Toshiba	
4-Bit Arithmetic Array	CD4057B	† RCA	
4-Bit Arithmetic Logic Unit	MC14581BA	† Motorola	
	MC14581BC	Motorola	50
	CD40181B	† RCA	
	CD40181BE	RCA	
	SCL4581B	† SSS	
	SCL4581BE	SSS	
	TF4581A/B	† TI	
	TP4581A/B	TI	
Look-Ahead Carry Block	F4582BC	Fairchild	
	F4582BM	† Fairchild	
	MC14582BA	† Motorola	60
	MC14582BC	Motorola	
	CD40182B	† RCA	
	CD40182BE	RCA	
(Continued)			

Function	Device	Source	Line
Arithmetic Functions (Cont'd)			
Look-Ahead Carry Block (Continued)	SCL4582B	SSS	
	TF4582A/B	† TI	
	TP4582A/B	TI	
4-Bit Magnitude Comparator	F40085BC	Fairchild	70
	F40085BM	† Fairchild	
	HD14585B-2	† Harris	
	HD14585B-9	Harris	
	HD54C85	† Harris	
	HD74C85	Harris	
	MC14585BA	† Motorola	
	MC14585BC	Motorola	
	MM54C85	† National	
	MM74C85	National	80
	CD4063B	† RCA	
	CD4063BE	RCA	
	SCL4585B	† SSS	
	SCL4585BE	SSS	
	TC4585	Toshiba	
NBCD Adder (Natural Binary Coded Decimal)	MC14560BA	† Motorola	
	MC14560BC	Motorola	
Nines Complementer	MC14561BA	† Motorola	90
	MC14561BC	Motorola	
Data Path Switch	F4704BC	Fairchild	
	F4704BM	† Fairchild	
Arithmetic Logic Register Stack	F4705BC	Fairchild	
	F4705BM	† Fairchild	
Data Access Register (for memory address arithmetic)	F4707BC	Fairchild	100
	F4707BM	† Fairchild	
Buffers/Inverters			
Quad Low Impedance Buffer	SCL4441B	† SSS	
	SCL4441BE	SSS	
Hex Buffer/Converter (Non-Inverting)	SIL4010B	† Mitel	
	SIL4010BE	Mitel	
	CD4010AC	National	
	CD4010AM	† National	110
	CD4010B	† RCA	
	CD4010BE	RCA	
	HBF4010BE	SGS	
	SCL4010B	† SSS	
	SCL4010BE	SSS	
	CM4010A	† Solitron	
	CM4010AE	Solitron	
	TF4010A/B	† TI	
	TP4010A/B	† TI	
	TC4010	Toshiba	120
Hex Buffer/Converter (Non-Inverting)-Improved	F4050BC	Fairchild	
	F4050BM	† Fairchild	
	HD4050B-2	† Harris	
(Continued)			

Function	Device	Source	Line
Buffers/Inverters (Cont'd)			
Hex Buffer/Converter (Non-Inverting)-Improved (Continued)	HD4050B-9	Harris	130
	SIL4050B	† Mitel	
	SIL4050BE	Mitel	
	MC14050BA	† Motorola	
	MC14050BC	Motorola	
	CD4050BC	National	
	CD4050BM	National	
	CD4050B	† RCA	
	CD4050BE	RCA	
	HBF4050AE	SGS	
	SCL4050B	† SSS	140
	SCL4050BE	SSS	
	CM4050A	† Solitron	
	CM4050AE	Solitron	
	SW4050AE	SW	
	TF4050A/B	† TI	
	TP4050A/B	TI	
	TC4050	Toshiba	
Hex Buffer, Open Drain (Active pull down)	HD54C906	† Harris	
	HD74C906	Harris	150
	MM54C906	† National	
	MM74C906	National	
Hex Buffer, Open Drain (Active pull up)	HD54C907	† Harris	
	HD74C907	Harris	
	MM54C907	† National	
	MM74C907	National	
Hex Buffer, Three-State	F40097BC	Fairchild	
	F40097BM	† Fairchild	160
	HD14503B-2	† Harris	
	HD14503B-9	Harris	
	HD70C95	† Harris	
	HD70C97	† Harris	
	HD80C95	Harris	
	HD80C97	Harris	
	MC14503BA	† Motorola	
	MC14503BC	Motorola	
	MM70C95	† National	
	MM70C97	† National	170
	MM80C95	National	
	MM80C97	National	
Hex Buffer/Converter (Inverting)	SIL4009B	† Mitel	
	SIL4009BE	Mitel	
	CD4009AC	National	
	CD4009AM	† National	
	CD4009UB	† RCA	
	CD4009UBE	RCA	
	HBF4009AE	SGS	180
	SCL4009B	† SSS	
	SCL4009BE	SSS	
	CM4009A	† Solitron	
	CM4009AE	Solitron	
	TF4009A	† TI	
	TP4009A	TI	
	TC4009	Toshiba	
Hex Buffer/Converter (Inverting)-Improved	F4049BC	Fairchild	
(Continued)			190

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—CMOS (Cont'd)

Function	Device	Source	Line
Buffers/Inverters (Cont'd)			
Hex Buffer/Converter (Inverting)-Improved (Continued)			
	F4049BM	† Fairchild	
	HD4049UB-2	† Harris	
	HD4049UB-9	Harris	
	SIL4049B	† Mitel	
	SIL4049BE	Mitel	
	MC14049BA	† Motorola	
	MC14049BC	Motorola	10
	CD4049UBC	National	
	CD4049UBM	† National	
	CD4049UB	† RCA	
	CD4049UBE	RCA	
	HBF4049AE	SGS	
	SCL4049B	† SSS	
	SCL4049BE	SSS	
	CM4049A	† Solitron	
	CM4049AE	Solitron	
	SW4049AE	SW	20
	TF4049A/UB	† TI	
	TP4049A/UB	TI	
	TC4049	Toshiba	
Hex Inverter			
	F4069UBC	Fairchild	
	F4069UBM	† Fairchild	
	HD54C04	† Harris	
	HD74C04	Harris	
	HD4069UB-9	† Harris	
	HD4069UB-9	Harris	30
	SIL4069B	† Mitel	
	SIL4069BE	Mitel	
	MC14069BA	† Motorola	
	MC14069BC	Motorola	
	MC14572A	† Motorola	
	MC14572C	Motorola	
	CD4069UBC	National	
	CD4069UBM	† National	
	MM54C04	† National	
	MM74C04	† National	40
	CD4069UB	† RCA	
	CD4069UBE	RCA	
	SCL4069B	† SSS	
	SCL4069BE	SSS	
	SCL4449B	† SSS	
	SCL4449BE	SSS	
	CM4069A	† Solitron	
	CM4069AE	Solitron	
	MM74C04	Teledyne S	
	TF4069A	† TI	50
	TP4069A	TI	
	TF4315A/UB	† TI	
	TP4315A/UB	TI	
	TC4069	Toshiba	
	TC7404	Toshiba	
Hex Inverter, Three-State			
	F40098BC	Fairchild	
	F40098BM	† Fairchild	
	MM80C96	National	
	MM80C98	National	60
Hex Inverter/Buffer, Three-State, Strobed			
	SIL4502B	† Mitel	
	SIL4502BE	Mitel	
	MC14502BA	† Motorola	
	(Continued)		

Function	Device	Source	Line
Buffers/Inverters (Cont'd)			
Hex Inverter/Buffer, Three-State, Strobed (Continued)			
	MC14502BC	Motorola	
	CD4502B	† RCA	70
	CD4502BE	RCA	
	SCL4502B	† SSS	
	SCL4502BF	SSS	
Hex CMOS Compatible Buffer			
	DS1630	† National	
	DS3630	National	
Dual Complementary Pair plus Inverter			
	F4007UBC	Fairchild	
	F4007UBM	† Fairchild	
	MEM4007D	† GI	80
	MEM4007P	GI	
	HD4007B-2	† Harris	
	HD4007B-9	Harris	
	SIL4007B	† Mitel	
	SIL4007BE	† Mitel	
	MC14007BA	† Motorola	
	MC14007BC	Motorola	
	CD4007UBC	National	
	CD4007UBM	† National	
	CD4007UB	† RCA	90
	CD4007UBE	RCA	
	HBF4007AE	SGS	
	SCL4007B	† SSS	
	SCL4007BE	SSS	
	CM4007A	† Solitron	
	CM4007AE	Solitron	
	TF4007A	† TI	
	TP4007A	TI	
	TC4007	Toshiba	
Quad True/Complement Buffer			100
	F4041BC	Fairchild	
	F4041BM	† Fairchild	
	CD4041BC	National	
	CD4041BM	† National	
	CD4041C	National	
	CD4041M	National	
	CD4041UB	† RCA	
	CD4041UBE	RCA	
	SCL4041B	† SSS	
	SCL4041BE	SSS	110
	CM4041A	† Solitron	
	CM4041AE	Solitron	
Counters, Binary			
Divide by 2, 8 or 16 Counters			
	HD54C93	† Harris	
	HD74C93	Harris	
	MM54C93	† National	
	MM74C93	National	
7-Stage Binary Counter			
	F4024BC	Fairchild	120
	F4024BM	† Fairchild	
	HD4024B-2	† Harris	
	HD4024B-9	Harris	
	SIL4024B	† Mitel	
	SIL4024BE	Mitel	
	MC14024BA	† Motorola	
	MC14024BC	Motorola	
	CD4024BC	National	
	(Continued)		

Function	Device	Source	Line
Counters, Binary (Cont'd)			130
7-Stage Binary Counter (Continued)			
	CD4024BM	† National	
	CD4024B	† RCA	
	CD4024BE	RCA	
	HBF4024AE	SGS	
	SCL4024B	† SSS	
	SCL4024BE	SSS	
	CM4024A	† Solitron	
	CM4024AE	Solitron	140
	SW4024AE	SW	
	TF4024A/B	† TI	
	TP4024A/B	TI	
	TC4024	Toshiba	
8-Stage Synchronous Binary Counter			
	SCL4404B	† SSS	
	SCL4404BE	SSS	
12-Stage Binary Counter			
	F4040BC	Fairchild	
	F4040BM	† Fairchild	150
	HD4040B-2	Harris	
	HD4040B-9	Harris	
	SIL4040B	† Mitel	
	SIL4040BE	Mitel	
	MC14040BA	† Motorola	
	MC14040BC	Motorola	
	CD4040BC	National	
	CD4040BM	† National	
	CD4040B	† RCA	
	CD4040BE	RCA	160
	CDS4040	† RCA	
	CDS4040E	RCA	
	SCL4040B	† SSS	
	SCL4040BE	SSS	
	CM4040A	† Solitron	
	CM4040AE	Solitron	
	TF4040A/B	† TI	
	TP4040A/B	TI	
	TC4040	Toshiba	
14-Stage Binary Counter			170
	F4020BC	Fairchild	
	F4020BM	† Fairchild	
	HD4020B-2	† Harris	
	HD4020B-9	Harris	
	MC14020BA	† Motorola	
	MC14020BC	Motorola	
	SIL4020B	† Mitel	
	SIL4020BE	Mitel	
	CD4020BC	National	
	CD4020BM	† National	180
	CD4020B	† RCA	
	CD4020BE	RCA	
	CDS4020	† RCA	
	CDS4020E	RCA	
	HBF4020AE	SGS	
	SCL4020B	† SSS	
	SCL4020BE	SSS	
	CM4020A	† Solitron	
	CM4020AE	Solitron	
	SW4020AE	SW	190
	TF4020A/B	† TI	
	TP4020A/B	TI	
	TC4020	Toshiba	

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—CMOS (Cont'd)

Function	Device	Source	Line
Counters, Binary (Cont'd)			
14-Stage Binary Counter and Oscillator			
	SIL4060B	† Mitel	
	SIL4060BE	Mitel	
	CD4060B	† RCA	
	CD4060BE	RCA	
	CDS4060	† RCA	
	CDS4060E	RCA	
	SCL4060B	† SSS	
	SCL4060BE	SSS	10
Presettable Synchronous Binary Counter, Asynchronous Clear			
	F40161BC	Fairchild	
	F40161BM	† Fairchild	
	HD54C161	† Harris	
	HD74C161	Harris	
	MC14161BA	† Motorola	
	MC14161BC	Motorola	
	CD40161BC	National	
	CD40161BM	† National	20
	MM54C161	† National	
	MM74C161	National	
	SCL4161B	† SSS	
	SCL4161BE	SSS	
	MM74C161	Teledyne S	
	TF4361A/UB	† TI	
	TP4361A/UB	TI	
Presettable Fully Synchronous Binary Counter, Synchronous Clear			
	F40163BC	Fairchild	30
	F40163BM	† Fairchild	
	HD54C163	† Harris	
	HD74C163	Harris	
	MC14163BA	† Motorola	
	MC14163BC	Motorola	
	MM54C163	† National	
	MM74C163	National	
	SCL4163B	† SSS	
	SCL4163BE	SSS	
	MM74C163	Teledyne S	40
	TF4363A/B	† TI	
	TP4363A/B	TI	
Dual Synchronous Binary Counter			
	F4520BC	Fairchild	
	F4520BM	† Fairchild	
	HD14520B-2	† Harris	
	HD14520B-9	Harris	
	SIL4520B	† Mitel	
	SIL4520BE	Mitel	
	MC14520BA	† Motorola	50
	MC14520BC	Motorola	
	CD4520BC	National	
	CD4520BM	† National	
	CD4520B	† RCA	
	CD4520BE	RCA	
	CDS4520	† RCA	
	CDS4520E	RCA	
	SCL4520B	† SSS	
	SCL4520BE	SSS	
	CM4520B	† Solitron	60
	CM4520BE	Solitron	
	TF4520A/B	† TI	
	TP4520A/B	TI	
	TC4520	Toshiba	

Function	Device	Source	Line
Counters, Binary (Cont'd)			
Presettable Binary Up/Down Counter			
	F40193BC	Fairchild	
	F40193BM	† Fairchild	
	F4516BC	Fairchild	
	F4516BM	† Fairchild	70
	HD14516B-2	† Harris	
	HD14516B-9	Harris	
	HD54C193	† Harris	
	HD74C193	Harris	
	SIL4516B	† Mitel	
	SIL4516BE	Mitel	
	MC14516BA	† Motorola	
	MC14516BC	Motorola	
	CD40193BC	National	
	CD40193BM	† National	80
	CD4516BC	National	
	CD4516BM	† National	
	MM54C193	† National	
	MM74C193	National	
	CD40193B	† RCA	
	CD40193BE	RCA	
	CD4516B	† RCA	
	CD4516BE	RCA	
	SCL4516B	† SSS	
	SCL4516BE	SSS	90
	MM74C193	Teledyne S	
	TF4516A/B	† TI	
	TP4516A/B	TI	
	TC4516	Toshiba	
Presettable 8-bit Binary Down Counter			
	CD40103B	† RCA	
	CD40103BE	RCA	
Programmable Binary Divide-by-N 4-Bit Counter			
	F4526BC	Fairchild	100
	F4526BM	† Fairchild	
	HD14526B-2	† Harris	
	HD14526B-9	Harris	
	MC14526BA	† Motorola	
	MC14526BC	Motorola	
	SCL4526B	† SSS	
	SCL4526BE	SSS	
	TF4526A/B	† TI	
	TP4526A/B	TI	
Counters, Decade			110
Presettable Decade Counter (Sets to 0 or 9, divides by 2, 5 or 10)			
	HD54C90	† Harris	
	HD74C90	Harris	
	MM54C90	† National	
	MM74C90	National	
Presettable Synchronous Decade Counter, Asynchronous Clear			
	F40160BC	Fairchild	
	F40160BM	† Fairchild	120
	HD54C160	† Harris	
	HD74C160	Harris	
	MC14160BA	† Motorola	
	MC14160BC	Motorola	
	CD40160BC	National	
	CD40160BM	† National	
	MM54C160	† National	
(Continued)			

Function	Device	Source	Line
Counters, Decade (Cont'd)			
Presettable Synchronous Decade Counter, Asynchronous Clear (Continued)			130
	MM74C160	National	
	SCL4160B	† SSS	
	SCL4160BE	SSS	
	MM74C160	Teledyne S	
	TF4360A/B	† TI	
	TP4360A/B	TI	
Presettable Fully Synchronous Decade Counter, Synchronous Clear			
	F40162BC	Fairchild	140
	F40162BM	† Fairchild	
	HD54C162	† Harris	
	HD74C162	Harris	
	MC14162BA	† Motorola	
	MC14162BC	Motorola	
	CD40162BC	National	
	CD40162BM	† National	
	MM54C162	† National	
	MM74C162	National	
	SCL4162B	† SSS	150
	SCL4162BE	SSS	
	MM74C162	Teledyne S	
	TF4362A/B	† TI	
	TP4362A/B	TI	
Dual Synchronous Decade Counter			
	F4518BC	Fairchild	
	F4518BM	† Fairchild	
	HD14518B-2	† Harris	
	HD14518B-9	Harris	
	SIL4518B	† Mitel	160
	SIL4518BE	Mitel	
	MC14518BA	† Motorola	
	MC14518BC	Motorola	
	CD4518BC	National	
	CD4518BM	† National	
	CD4518B	† RCA	
	CD4518BE	RCA	
	CDS4518	† RCA	
	CDS4518E	RCA	
	SCL4518B	† SSS	170
	SCL4518BE	SSS	
	CM4518B	† Solitron	
	CM4518BE	Solitron	
	TF4518A/B	† TI	
	TP4518A/B	TI	
	TC4518	Toshiba	
Decade Counter/Divider, 10 line output			
	F4017BC	Fairchild	
	F4017BM	† Fairchild	
	HD4017B-2	† Harris	180
	HD4017B-9	Harris	
	SIL4017B	† Mitel	
	SIL4017BE	Mitel	
	MC14017BA	† Motorola	
	MC14017BC	Motorola	
	CD4017BC	National	
	CD4017BM	† National	
	CD4017B	† RCA	
	CD4017BE	RCA	
	CDS4017	† RCA	190
	CDS4017E	RCA	
	HBF4017AE	SGS	
(Continued)			

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—CMOS (Cont'd)

Counters, Decade (Cont'd)

Function	Device	Source	Line
Decade Counter/Divider, 10 line output (Continued)			
	SCL4017B	† SSS	
	SCL4017BE	SSS	
	CM4017A	† Solitron	
	CM4017AE	Solitron	
	SW4017AE	SW	
	TF4017A	† TI	
	TP4017A	TI	10
	TC4017	Toshiba	
Presettable Decade Up/Down Counter			
	F40192BC	Fairchild	
	F40192BM	† Fairchild	
	F4510BC	Fairchild	
	F4510BM	† Fairchild	
	HD14510B-2	† Harris	
	HD14510B-9	Harris	
	HD54C192	† Harris	
	HD74C192	Harris	20
	SIL4510B	† Mitel	
	SIL4510BC	Mitel	
	MC14510BA	† Motorola	
	MC14510BC	Motorola	
	CD40192BC	National	
	CD40192BM	† National	
	CD4510BC	National	
	CD4510BM	† National	
	MM54C192	† National	
	MM74C192	National	30
	CD40192B	† RCA	
	CD40192BE	RCA	
	CD4510B	† RCA	
	CD4510BE	RCA	
	SCL4510B	† SSS	
	SCL4510BE	SSS	
	MM74C192	Teledyne S	
	TC4510	Toshiba	
Presettable 2-Decade Down Counter			
	CD40102A/B	† RCA	40
	CD40102A/BE	RCA	
Programmable Decade Divide-By-N 4-Bit Counter			
	F4522BC	Fairchild	
	F4522BM	† Fairchild	
	HD14522B-2	† Harris	
	HD14522B-9	Harris	
	MC14522BA	† Motorola	
	MC14522BC	Motorola	
	SCL4522B	† SSS	50
	SCL4522BE	SSS	
	TF4522A/B	† TI	
	TP4522A/B	TI	
4-Decade Divide-by-N Counter			
	CD4059A	† RCA	
	CD4059AE	RCA	
Presettable Up/Down Decade Counter-7 Segment Display and BCD Output			
	HCTR0200	Hughes	
Decade Counter/Divider-7 Segment Display Output and Display Enable			60
	CD4026B	† RCA	
	CD4026BE	RCA	
	SCL4026B	† SSS	
	(Continued)		

Function	Device	Source	Line
Decade Counter/Divider-7 Segment Display Output and Display Enable (Continued)			
	SCL4026BE	SSS	
	SCL4426B	† SSS	70
	SCL4426BE	SSS	
	CM4026A	† Solitron	
	CM4026AE	Solitron	
Decade Counter/Divider-7 Segment Display Output and Ripple Blanking			
	CD4033B	† RCA	
	CD4033BE	RCA	
	HBF4033AE	SGS	
	SCL4033B	† SSS	
	SCL4033BE	SSS	80
	SCL4433B	† SSS	
	SCL4433BE	SSS	
	CM4033A	† Solitron	
	CM4033AE	Solitron	
3-1/2 Digit Counter to BCD Driver			
	CM4102	† Solitron	
	CM4102	Solitron	
3 Decade Counter, Multiplexed Output			
	F4553BC	Fairchild	
	F4553BM	† Fairchild	90
	MC14553BA	† Motorola	
	MC14553BC	Motorola	
4 Decade Counter			
	TC5001	Toshiba	
4 Decade Counter, Multiplexed Output			
	HD54C925	† Harris	
	HD54C926	† Harris	
	HD74C925	Harris	
	HD74C926	Harris	
	MM54C925	† National	100
	MM74C925	National	
	MM54C926	† National	
	MM74C926	National	
4 Digit Counter, Multiplexed Output, Second digit counts to 6 (Maximum count 9599.)			
	HD54C927	† Harris	
	HD74C927	Harris	
	MM54C927	† National	
	MM74C927	National	
4 Digit Counter, Multiplexed Output, left digit counts to 2 (Maximum count 1999.)			110
	HD54C928	† Harris	
	HD74C928	Harris	
	MM54C928	† National	
	MM74C928	National	
4 Decade Counter, Presettable, Multiplexed 7 Segment Output and Addressable Output (Maximum count 39999)			
	HCTR0154	Hughes	
4-1/2 Digit Up-Down Counter Oscillator (Maximum count 19999)			120
	HCTR4010	Hughes	
	HCTR6010	Hughes	
5 Decade Counter, Multiplexed Output			
	MC14534BA	† Motorola	
	MC14534BC	Motorola	

Function	Device	Source	Line
7 Decade Counter, Multiplexer, Display Driver, 2-6v Supply			
	7208	Intersil	130

Counters, Miscellaneous

Function	Device	Source	Line
Presettable Up/Down Binary or Decade Counter			
	F4029BC	Fairchild	
	F4029BM	† Fairchild	
	HD4029B-2	† Harris	
	HD4029B-9	Harris	
	SIL4029B	† Mitel	
	SIL4029BE	Mitel	
	CD4029BC	National	140
	CD4029BM	† National	
	CD4029B	† RCA	
	CD4029BE	RCA	
	HBF4029AE	SGS	
	SCL4029B	† SSS	
	SCL4029BE	SSS	
	CM4029A	† Solitron	
	CM4029AE	Solitron	
	SW4029BE	SW	
	TF4029A	† TI	150
	TP4029A	TI	
	TC4029	Toshiba	
Dual Programmable Binary/Decade Counter			
	MC14569BA	† Motorola	
	MC14569BC	Motorola	
Divide-by-8-Counter/Divider, Decoded Output			
	F4022BC	Fairchild	
	F4022BM	† Fairchild	
	HD4022B-2	† Harris	160
	HD4022B-9	Harris	
	SIL4022B	† Mitel	
	SIL4022BE	Mitel	
	MC14022BA	† Motorola	
	MC14022BC	Motorola	
	CD4022BC	National	
	CD4022BM	† National	
	CD4022B	† RCA	
	CD4022BE	RCA	
	HBF4022AE	SGS	170
	SCL4022B	† SSS	
	SCL4022BE	SSS	
	CM4022A	† Solitron	
	CM4022AE	Solitron	
	TF4022A	† TI	
	TP4022A	TI	
	TC4022	Toshiba	
Divide-by-60-Counter, BCD Output (Industrial Time Base Generator)			
	MC14566BA	† Motorola	180
	MC14566BC	Motorola	
Presettable Divide-by-N Counter			
	F4018BC	Fairchild	
	F4018BM	† Fairchild	
	HD4018B-2	† Harris	
	HD4018B-9	Harris	
	SIL40188B	† Mitel	
	SIL40188BE	Mitel	
	MC14018BA	† Motorola	
	(Continued)		190

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—CMOS (Cont'd)

Function	Device	Source	Line
Counters, Miscellaneous (Cont'd)			
Presettable Divide-by-N Counter (Continued)			
	MC14018BC	Motorola	
	CD4018B	† RCA	
	CD4018BE	RCA	
	CD4018BC	National	
	CD4018BM	† National	
	HBF4018AE	SGS	
	SCL4018B	† SSS	10
	SCL4018BE	SSS	
	CM4018A	† Solitron	
	CM4018AE	Solitron	
	TF4018A/B	† TI	
	TP4018A/B	TI	
	TC4018	Toshiba	
Phase Comparator and Programmable Counters			
	MC14568BA	† Motorola	
	MC14568BC	Motorola	20
Decoders			
BCD-to-Decimal Decoder			
	F4028BC	Fairchild	
	F4028BM	† Fairchild	
	HD4028B-2	† Harris	
	HD4028B-9	Harris	
	HD54C42	† Harris	
	HD74C42	Harris	
	SIL4028B	† Mitel	
	SIL4028BE	Mitel	30
	MC14028BA	† Motorola	
	MC14028BC	Motorola	
	CD4028BC	National	
	CD4028BM	† National	
	MM54C42	† National	
	MM74C42	National	
	CD4028B	† RCA	
	CD4028BE	RCA	
	HBF4028AE	SGS	
	SCL4028B	† SSS	40
	SCL4028BE	SSS	
	CM4028A	† Solitron	
	CM4028AE	Solitron	
	SW4028AE	SW	
	MM74C42	Teledyne S	
	TF4028A/B	† TI	
	TP4028A/B	TI	
	TC4028	Toshiba	
BCD-to-7-Segment Decoder			
	HD54C48	† Harris	50
	HD74C48	Harris	
	HD14558B-2	† Harris	
	HD14558B-9	Harris	
	MC14558BA	† Motorola	
	MC14558BC	Motorola	
	MM54C48	† National	
	MM74C48	National	
	UCN-4102A	Sprague	
	TC5002	Toshiba	
4-bit Latch/4-to-16-Line Decoder (High)			60
	F4514BC	Fairchild	
	F4514BM	† Fairchild	
	HD14514B-2	† Harris	
	(Continued)		

Function	Device	Source	Line
Decoders (Cont'd)			
4-bit Latch/4-to-16-Line Decoder (High) (Continued)			
	HD14514B-9	Harris	
	SIL4514BE	Mitel	
	SIL4514B	† Mitel	70
	MC14514BA	† Motorola	
	MC14514BC	Motorola	
	CD4514B	† RCA	
	CD4514BE	RCA	
	SCL4514B	† SSS	
	CM4514B	† Solitron	
	CM4514BE	Solitron	
	TC4514	Toshiba	
4-bit Latch/4-to-16-Line Decoder (Low)			
	F4515BC	Fairchild	80
	F4515BM	† Fairchild	
	HD14515B-2	† Harris	
	HD14515B-9	Harris	
	SIL4515B	† Mitel	
	SIL4515BE	Mitel	
	MC14515BA	† Motorola	
	MC14515BC	Motorola	
	CD4515B	† RCA	
	CD4515BE	RCA	
	SCL4515B	† SSS	90
	CM4515B	† Solitron	
	CM4515BE	Solitron	
	TC4515	Toshiba	
Dual Binary to 1 of 4 Decoder/Demultiplexer (High)			
	F4555BC	Fairchild	
	F4555BM	† Fairchild	
	MC14555BA	† Motorola	
	MC14555BC	Motorola	
	CD4555B	† RCA	100
	CD4555BE	RCA	
	SCL4555B	† SSS	
	TF14555A/B	† TI	
	TP14555A/B	TI	
Dual Binary to 1 of 4 Decoder/Demultiplexer (Low)			
	F4556BC	Fairchild	
	F4556BM	† Fairchild	
	MC14556BA	† Motorola	
	MC14556BC	Motorola	110
	CD4556B	† RCA	
	CD4556BE	RCA	
	SCL4556B	† SSS	
	TF14556A/B	† TI	
	TP14556A/B	TI	
4-Line-to-16-Line Decoder/Demultiplexer			
	HD54C154	† Harris	
	HD74C154	Harris	
	MM54C154	† National	
	MM74C154	National	120
	MM74C154	Teledyne S	
1 of 8 Strobed Decoder			
	SCL4428B	† SSS	
	SCL4428BE	SSS	

Function	Device	Source	Line
Drivers			
BCD-to-7-Segment Latch/Decoder/Driver			
	F4511BC	Fairchild	
	F4511BM	† Fairchild	
	F4734BC	† Fairchild	
	F4734BM	Fairchild	130
	HD14511B-2	† Harris	
	HD14511B-9	Harris	
	MC14511BA	† Motorola	
	MC14511BC	Motorola	
	SIL4511B	† Mitel	
	SIL4511BE	Mitel	
	CD4511BC	National	
	CD4511BM	† National	
	CD4511B	† RCA	
	CD4511BE	RCA	140
	SCL4511B	† SSS	
	SCL4511BE	SSS	
	CM4511B	† Solitron	
	CM4511BE	Solitron	
	TF4511A/B	† TI	
	TP4511A/B	TI	
BCD-to-7-Segment Latch/Decoder/Driver (for Liquid Crystal Displays)			
	HD14543B-2	† Harris	
	HD14543B-9	Harris	150
	MC14543BA	† Motorola	
	MC14543BC	Motorola	
	SCL4543B	SSS	
BCD-to-7-Segment Liquid Crystal Decoder/ Driver with "Display Frequency Output"			
	CD4055B	† RCA	
	CD4055BE	RCA	
BCD-to-7-Segment Liquid Crystal Decoder/ Driver with Strobed-Latch Function			
	CD4056B	† RCA	160
	CD4056BE	RCA	
4-Line Liquid Crystal Display Driver			
	CD4054B	† RCA	
	CD4054BE	RCA	
4-Digit Liquid Crystal Display Driver			
	5015	Nortec	
	SCL5424	SSS	
	SCL5441	SSS	
8-Digit LED Display Driver			
	SCL5440A	† SSS	170
Dual High Voltage Driver, Source 250 ma			
	HD54C908	† Harris	
	HD74C908	Harris	
	MM74C908	National	
	MM74C918	National	
Dual and Quad Line Drivers-See Miscellaneous			
Flip-Flops			
Dual "D" Flip-Flop			
	F4013BC	Fairchild	180
	F4013BM	† Fairchild	
	MEM4013D	† GI	
	MEM4013P	GI	
	HD4013B-2	† Harris	
	HD4013B-9	Harris	
	HD54C74	† Harris	
	(Continued)		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—CMOS (Cont'd)

Flip-Flops (Cont'd)

Function	Device	Source	Line
Dual "D" Flip-Flop (Continued)			
	HD74C74	Harris	
	SIL4013B	† Mitel	
	SIL4013BE	Mitel	
	MC14013BA	† Motorola	
	MC14013BC	Motorola	
	CD4013BC	National	
	CD4013BM	† National	
	MM54C74	† National	10
	MM74C74	National	
	CD4013B	† RCA	
	CD4013BE	RCA	
	HBF4013AE	SGS	
	SCL4013B	† SSS	
	SCL4013BE	SSS	
	CM4013A	† Solitron	
	CM4013AE	Solitron	
	SW4013AE	SW	
	MM74C74	Teledyne S	20
	TF4013A/B	† TI	
	TP4013A/B	TI	
	TC4013	Toshiba	
Quad "D" Flip-Flop			
	F40175BC	Fairchild	
	F40175BM	† Fairchild	
	HD54C175	† Harris	
	HD74C175	Harris	
	MC14175BA	† Motorola	
	MC14175BC	Motorola	30
	MM54C175	† National	
	MM74C175	National	
	CD40175B	National	
	TF4175B	† TI	
	TP4175B	TI	
Quad "D" Flip-Flop, Three-State			
	F4076BC	Fairchild	
	F4076BM	† Fairchild	
	HD4076B-2	Harris	
	HD4076B-9	Harris	40
	HD54C173	† Harris	
	HD74C173	Harris	
	MC14076BA	Motorola	
	MC14076BC	Motorola	
	MM54C173	† National	
	MM74C173	National	
	CD4076BC	National	
	CD4076BM	† National	
	CD4076B	† RCA	
	CD4076BE	RCA	50
	SCL4076B	† SSS	
	SCL4076BE	SSS	
	CM4076A	† Solitron	
	CM4076AE	Solitron	
	MM74C173	Teledyne S	
	TF4076B	† TI	
	TP4076B	TI	
Hex "D" Flip-Flop			
	F40174BC	Fairchild	
	F40174BM	† Fairchild	60
	HD54C174	† Harris	
	HD74C174	Harris	
	MC14174BA	† Motorola	
	MC14174BC	Motorola	
	(Continued)		

Flip-Flops (Cont'd)

Function	Device	Source	Line
Hex "D" Flip-Flop (Continued)			
	CD40174BC	National	
	CD40174BM	† National	
	MM54C174	† National	70
	MM74C174	National	
	TF4370A/B	† TI	
	TP4370A/B	TI	
Dual "J-K" Flip-Flop			
	F4027BC	Fairchild	
	F4027BM	† Fairchild	
	HD4027B-2	† Harris	
	HD4027B-9	Harris	
	HD54C76	† Harris	
	HD74C76	Harris	80
	SIL4027B	† Mitel	
	SIL4027BE	Mitel	
	MC14027BA	† Motorola	
	MC14027BC	Motorola	
	CD4027BC	National	
	CD4027BM	† National	
	MM54C76	† National	
	MM74C76	National	
	CD4027B	† RCA	
	CD4027BE	RCA	90
	HBF4027AE	SGS	
	SCL4027B	† SSS	
	SCL4027BE	SSS	
	CM4027A	† Solitron	
	CM4027AE	Solitron	
	SW4027AE	SW	
	MM74C76	Teledyne S	
	TF4027A/B	† TI	
	TP4027A/B	TI	
	TC4027	Toshiba	100
	TC7476	Toshiba	
Dual "J-K" Flip-Flop W/O Preset			
	HD54C73	† Harris	
	HD74C73	Harris	
	HD54C107	† Harris	
	HD74C107	Harris	
	MM54C73	† National	
	MM74C73	National	
	MM54C107	† National	
	MM74C107	National	110
	MM74C73	Teledyne S	
	MM74C107	Teledyne S	

Gates, AND/NAND

Function	Device	Source	Line
AND Gated "J-K" Flip-Flop			
	CD4095B	† RCA	
	CD4095BE	RCA	
	CD4096B	† RCA	
	CD4096BE	RCA	
8-Input AND Gate			
	SIL4968B	† Mitel	120
	SIL4968BE	Mitel	
Dual 4-Input AND Gate			
	F4082BC	Fairchild	
	F4082BM	† Fairchild	
	HD4082B-2	† Harris	
	HD4082B-9	Harris	
	SIL4082B	† Mitel	
	(Continued)		

Gates, AND/NAND (Cont'd)

Function	Device	Source	Line
Dual 4-Input AND Gate (Continued)			130
	SIL4082BE	Mitel	
	MC14082BA	† Motorola	
	MC14082BC	Motorola	
	CD4082B	† RCA	
	CD4082BE	RCA	
	SCL4082B	SSS	
	SCL4082BE	† SSS	
	TF4082B	† TI	
	TP4082B	TI	
	TC4082	Toshiba	140
Triple 3-Input AND Gate			
	F4073BC	Fairchild	
	F4073BM	† Fairchild	
	SIL4073B	† Mitel	
	SIL4073BE	Mitel	
	MC14073BA	† Motorola	
	MC14073BC	Motorola	
	CD4073B	† RCA	
	CD4073BE	RCA	
	SCL4073B	† SSS	150
	SCL4073BE	SSS	
	CM4073A	† Solitron	
	CM4073AE	Solitron	
	TF4073B	† TI	
	TP4073B	TI	
	TC4073	Toshiba	
Quad 2-Input AND Gate			
	F4081BC	Fairchild	
	F4081BM	† Fairchild	
	HD4081B-2	† Harris	160
	HD4081B-9	Harris	
	HD54C08	† Harris	
	HD74C08	Harris	
	SIL4081B	† Mitel	
	SIL4081BE	Mitel	
	MC14081A	† Motorola	
	MC14081C	Motorola	
	CD4081BC	National	
	CD4081BM	† National	
	MM54C08	† National	170
	MM74C08	National	
	CD4081B	† RCA	
	CD4081BE	RCA	
	SCL4081B	† SSS	
	SCL4081BE	SSS	
	CM4081A	† Solitron	
	CM4081AE	Solitron	
	TF4081B	† TI	
	TP4081B	TI	
	TC4081	Toshiba	180
8-Input NAND Gate			
	F4068BC	Fairchild	
	F4068BM	† Fairchild	
	HD54C30	† Harris	
	HD74C30	Harris	
	SIL4068B	† Mitel	
	SIL4068BE	Mitel	
	MC14068BA	† Motorola	
	MC14068BC	Motorola	
	MC14501A	† Motorola	190
	MC14501C	Motorola	
	MM54C30	† National	
	(Continued)		

† Military Temperature Range (−55°C to 125°C)

IC MASTER

DIGITAL—CMOS (Cont'd)

Gates, AND/NAND (Cont'd)

Function	Device	Source	Line
8-Input NAND Gate (Continued)			
	MM74C30	National	
	CD4068B	† RCA	
	CD4068BE	RCA	
	SCL4068B	† SSS	
	SCL4068BE	SSS	
	SCL4412B	† SSS	
	SCL4412BE	SSS	
	CM4068A	† Solitron	10
	CM4068AE	Solitron	
	TF4068B	† TI	
	TP4068B	TI	
	TC4068	Toshiba	
Dual 4-Input NAND Gate			
	F4012BC	Fairchild	
	F4012BM	† Fairchild	
	HD4012B-2	† Harris	
	HD4012B-9	Harris	
	HD54C20	† Harris	20
	HD74C20	Harris	
	SIL4012UB	† Mitel	
	SIL4012UBE	Mitel	
	SIL4912B	† Mitel	
	SIL4912BE	Mitel	
	MC14012BA	† Motorola	
	MC14012BC	Motorola	
	CD4012AC	National	
	CD4012AM	† National	
	MM54C20	† National	30
	MM74C20	National	
	CD4012B	† RCA	
	CD4012BE	RCA	
	CD4012UB	† RCA	
	CD4012UBE	RCA	
	HBF4012AE	SGS	
	SCL4012B	† SSS	
	SCL4012BE	SSS	
	CM4012A	† Solitron	
	CM4012AE	Solitron	40
	SW4012AE	SW	
	MM74C20	Teledyne S	
	TF4012A	† TI	
	TP4012A	TI	
	TC4012	Toshiba	
	TC7420	Toshiba	
Dual 2-Input NAND Gate (Driver)			
	CD40107B	† RCA	
	CD40107BE	RCA	
Dual 4-Input Expandable NAND Gate			50
	SCL4412B	† SSS	
	SCL4412BE	SSS	
Triple 3-Input NAND Gate			
	F4023BC	Fairchild	
	F4023BM	† Fairchild	
	HD4023B-2	† Harris	
	HD4023B-9	Harris	
	HD54C10	† Harris	
	HD74C10	Harris	
	SIL4023UB	† Mitel	60
	SIL4023UBE	Mitel	
	SIL4923B	† Mitel	
	SIL4923BE	Mitel	
	MC14023A	† Motorola	
	(Continued)		

Gates, AND/NAND (Cont'd)

Function	Device	Source	Line
Triple 3-Input NAND Gate (Continued)			
	MC14023C	Motorola	
	MC14023BA	† Motorola	
	MC14023BC	Motorola	70
	CD4023A/BC	National	
	CD4023A/BM	† National	
	MM54C10	† National	
	MM74C10	National	
	CD4023B	† RCA	
	CD4023BE	RCA	
	CD4023UB	† RCA	
	CD4023UBE	RCA	
	HBF4023AE	SGS	
	SCL4023B	† SSS	80
	SCL4023BE	SSS	
	CM4023A	† Solitron	
	CM4023AE	Solitron	
	SW4023AE	SW	
	MM74C10	Teledyne S	
	TF4023A	† TI	
	TP4023A	TI	
	TC4023	Toshiba	
	TC7410	Toshiba	
Quad 2-Input NAND Gate			90
	F4011BC	Fairchild	
	F4011BM	† Fairchild	
	MEM4011D	† GI	
	MEM4011P	GI	
	HD4011B-2	† Harris	
	HD4011B-9	Harris	
	HD54C00	† Harris	
	HD74C00	Harris	
	SIL4011UB	† Mitel	
	SIL4011UBE	Mitel	100
	SIL4911B	† Mitel	
	SIL4911BE	Mitel	
	MC14011A	† Motorola	
	MC14011C	Motorola	
	MC14011BA	† Motorola	
	MC14011C	Motorola	
	CD4011A/BC	National	
	CD4011A/BM	† National	
	MM54C00	† National	
	MM74C00	National	110
	CD4011B	† RCA	
	CD4011BE	RCA	
	CD4011UB	† RCA	
	CD4011UBE	RCA	
	HBF4011AE	SGS	
	SCL4011B	† SSS	
	SCL4011BE	SSS	
	SCL4011UB	† SSS	
	SCL4011UBE	SSS	
	CM4011	† Solitron	120
	CM4011	Solitron	
	SW4011AE	SW	
	MM74C00	Teledyne S	
	TF4011A/B	† TI	
	TP4011A/B	TI	
	TF4311A/UB	† TI	
	TP4311A/UB	TI	
	TC4011	Toshiba	
	TC7400	Toshiba	

Gates, AND-OR/AND-OR-Invert

Function	Device	Source	Line
Triple AND-OR Bi-Phase Pairs			130
	CD4037B	† RCA	
	CD4037BE	RCA	
	CM4037A	† Solitron	
	CM4037AE	Solitron	
Quad AND-OR Select Gate			
	F4019BC	Fairchild	
	F4019BM	† Fairchild	
	F4519BC	Fairchild	
	F4519BM	† Fairchild	140
	HD14519B-2	† Harris	
	HD14519B-9	Harris	
	HD4019B-2	† Harris	
	HD4019B-9	Harris	
	SIL4019B	† Mitel	
	SIL4019BE	Mitel	
	MC14519BA	† Motorola	
	MC14519BC	Motorola	
	CD4019BC	National	
	CD4019BM	† National	150
	CD4519BC	National	
	CD4019B	† RCA	
	CD4019BE	RCA	
	HBF4019AE	SGS	
	SCL4019B	† SSS	
	SCL4019BE	SSS	
	CM4019A	† Solitron	
	CM4019AE	Solitron	
	SW4019AE	SW	
	TF4019A/B	† TI	160
	TP4019A/B	TI	
	TF4519A/B	† TI	
	TP4519A/B	TI	
	TC4019	Toshiba	
Quad AND-OR Select Gate, Three-State			
	CD40257B	† RCA	
	CD40257BE	RCA	
Dual 2-Wide 2-Input AND-OR-Invert Gate			
	F4085BC	Fairchild	
	F4085BM	Fairchild	170
	MC14506BA	† Motorola	
	MC14506BC	Motorola	
	CD4085B	† RCA	
	CD4085BE	RCA	
	TF4085B	† TI	
	TP4085B	TI	
4 Wide 2-Input Expandable AND-OR-Invert Gate			
	F4086BC	Fairchild	
	F4086BM	† Fairchild	180
	CD4086B	† RCA	
	CD4086BE	RCA	
Quad 4-2-2-1-Input AND-OR-Invert Gate			
	TF4302A/B	TI	
	TP4302A/B	TI	
Quad 2-4-4-1-Input AND-OR-Invert Gate			
	TF4303A/B	TI	
	TP4303A/B	TI	

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—CMOS (Cont'd)

Gates, Exclusive OR/NOR

Quad Exclusive OR Gate

Device	Source	Line
F4030BC	Fairchild	
F4030BM	† Fairchild	
F4070BC	Fairchild	
F4070BM	† Fairchild	
HD4030B-2	† Harris	
HD4030B-9	Harris	
HD4070B-2	† Harris	
HD4070B-9	Harris	10
HD54C86	† Harris	
HD74C86	Harris	
SIL4030B	† Mitel	
SIL4030BE	Mitel	
SIL4070B	† Mitel	
SIL4070BE	Mitel	
MC14507A	† Motorola	
MC14507C	Motorola	
MC14070BA	† Motorola	
MC14070BC	Motorola	20
CD4030AC	National	
CD4030AM	† National	
CD4070BC	National	
CD4070BM	† National	
MM54C86	† National	
MM74C86	National	
CD4030B	† RCA	
CD4030BE	RCA	
CD4070B	† RCA	
CD4070BE	RCA	30
HBF4030AE	SGS	
SCL4030B	† SSS	
SCL4030BE	SSS	
SCL4070B	† SSS	
SCL4070BE	SSS	
CM4030A	† Solitron	
CM4030AE	Solitron	
CM4070A	† Solitron	
CM4070AE	Solitron	
SW4030AE	SW	40
TF4030A	† TI	
TP4030A	TI	
TF4070B	† TI	
TP4070B	TI	
TF4507A/B	† TI	
TP4507A/B	TI	
TC4030	Toshiba	

Quad Exclusive NOR Gate

Device	Source	Line
F4077BC	Fairchild	
F4077BM	† Fairchild	50
F4519BC	Fairchild	
F4519BM	† Fairchild	
HD4077B-2	† Harris	
HD4077B-9	Harris	
HD14519B-2	† Harris	
HD14519B-9	Harris	
SIL4077B	† Mitel	
SIL4077BE	Mitel	
MC14077BA	† Motorola	
MC14077BC	Motorola	60
MC14519BA	† Motorola	
MC14519BC	Motorola	
CD4519BC	National	
CD4519BM	† National	
CD4077B	† RCA	

(Continued)

Gates, Exclusive OR/NOR (Cont'd)

Quad Exclusive NOR Gate (Continued)

Device	Source	Line
CD4077BE	RCA	70
CM4077A	† Solitron	
CM4077AE	Solitron	
SCL4077B	† SSS	
SCL4077BE	SSS	
TF4519A/B	† TI	
TP4519A/B	TI	

Gates, OR/NOR

8-Input OR Gate

Device	Source	Line
SIL4978B	† Mitel	
SIL4978BE	Mitel	80

Dual 4-Input OR Gate

Device	Source	Line
F4072BC	Fairchild	
F4072BM	† Fairchild	
SIL4072B	† Mitel	
SIL4072BC	Mitel	
MC14072BA	† Motorola	
MC14072BC	Motorola	
CD4072B	† RCA	
CD4072BE	RCA	
SCL4072B	† SSS	90
SCL4072BE	SSS	
TF4072B	† TI	
TP4072B	TI	
TC4072	Toshiba	

Triple 3-Input OR Gate

Device	Source	Line
F4075BC	Fairchild	
F4075BM	† Fairchild	
SIL4075B	† Mitel	
SIL4075BE	Mitel	
MC14075BA	† Motorola	100
MC14075BC	Motorola	
CD4075B	† RCA	
CD4075BE	RCA	
SCL4075B	† SSS	
SCL4075BE	SSS	
TF4075B	† TI	
TP4075B	TI	
TC4075	Toshiba	

Quad 2-Input OR Gate

Device	Source	Line
F4071BC	Fairchild	110
F4071BM	† Fairchild	
HD4071B-2	† Harris	
HD4071B-9	Harris	
HD54C32	† Harris	
HD74C32	Harris	
SIL4071B	† Mitel	
SIL4071BE	Mitel	
MC14071A	† Motorola	
MC14071C	Motorola	
MC14071BA	† Motorola	120
CD4071BC	National	
CD4071BM	† National	
MC14071BC	Motorola	
MM54C32	† National	
MM74C32	National	
CD4071B	† RCA	
CD4071BE	RCA	
SCL4071B	† SSS	
SCL4071BE	SSS	

(Continued)

Gates, OR/NOR (Cont'd)

Quad 2-Input OR Gate (Continued)

Device	Source	Line
CM4071A	† Solitron	
CM4071AE	Solitron	
TF4071B	† TI	
TP4071B	TI	
TC4071	Toshiba	

8-Input NOR Gate

Device	Source	Line
F4078BC	Fairchild	
F4078BM	† Fairchild	140
SIL4078B	† Mitel	
SIL4078BE	Mitel	
MC14078BA	† Motorola	
MC14078BC	Motorola	
CD4078B	† RCA	
CD4078BE	RCA	
SCL4078B	† SSS	
SCL4078BE	SSS	
SCL4402B	† SSS	
SCL4402BE	SSS	150
CM4078A	† Solitron	
CM4078AE	Solitron	
TC4078	Toshiba	

Dual 3-Input NOR Gate plus Inverter

Device	Source	Line
HD4000UB-2	† Harris	
HD4000UB-9	Harris	
SIL4000B	† Mitel	
SIL4000BE	Mitel	
MC14000A	† Motorola	
MC14000C	Motorola	160
CD4000B	† RCA	
CD4000BE	RCA	
CD4000UB	† RCA	
CD4000UBE	RCA	
SCL4000B	† SSS	
SCL4000BE	SSS	
CM4000A	Solitron	
CM4000AE	Solitron	
TF4000A	† TI	
TP4000A	TI	170

Dual 4-Input NOR Gate

Device	Source	Line
F4002BC	Fairchild	
F4002BM	† Fairchild	
HD4002B-2	† Harris	
HD4002B-9	Harris	
SIL4002UB	† Mitel	
SIL4002UBE	Mitel	
SIL4902B	† Mitel	
SIL4902BC	Mitel	
MC14002A	† Motorola	180
MC14002C	Motorola	
MC14002BA	† Motorola	
MC14002BC	Motorola	
CD4002AC	National	
CD4002AM	† National	
CD4002B	† RCA	
CD4002BE	RCA	
CD4002UB	† RCA	
CD4002UBE	RCA	
HBF4002AE	SGS	190
SCL4002B	† SSS	
SCL4002BE	SSS	
CM4002A	† Solitron	
CM4002AE	Solitron	

(Continued)

† Military Temperature Range (−55°C to 125°C)

DIGITAL—CMOS (Cont'd)

Function	Device	Source	Line
Gates, OR/NOR (Cont'd)			
Dual 4-Input NOR Gate (Continued)			
	SW4002AE	SW	
	TF4002A	† TI	
	TP4002A	TI	
	TC4002	Toshiba	
Dual 4-Input Expandable NOR Gate			
	SCL4402B	† SSS	
	SCL4402BE	SSS	
Triple 3-Input NOR Gate			10
	F4025BC	Fairchild	
	F4025BM	† Fairchild	
	HD4025B-2	† Harris	
	HD4025B-9	† Harris	
	SIL4025UB	† Mitel	
	SIL4025UBE	Mitel	
	SIL4925B	† Mitel	
	SIL4925BE	Mitel	
	MC14025A	† Motorola	
	MC14025C	Motorola	20
	MC14025BA	† Motorola	
	MC14025BC	Motorola	
	CD4025A/BC	National	
	CD4025A/BM	† National	
	CD4025B	† RCA	
	CD4025BE	RCA	
	CD4025UB	† RCA	
	CD4025UBE	RCA	
	HBF4025AE	SGS	
	SCL4025B	SSS	30
	SCL4025BE	SSS	
	CM4025A	Solitron	
	CM4025AE	Solitron	
	SW4025AE	SW	
	TF4025A	† TI	
	TP4025A	TI	
	TC4025	Toshiba	
Quad 2-Input NOR Gate			
	F4001BC	Fairchild	
	F4001BM	† Fairchild	40
	MEM4001D	† GI	
	MEM4001P	GI	
	HD4001B-2	† Harris	
	HD4001B-9	Harris	
	HD54C02	† Harris	
	HD74C02	Harris	
	SIL4001UB	† Mitel	
	SIL4001UBE	Mitel	
	SIL4901B	† Mitel	
	SIL4901BE	Mitel	50
	MC14001A	† Motorola	
	MC14001C	Motorola	
	MC14001BA	† Motorola	
	MC14001BC	Motorola	
	CD4001AC	National	
	CD4001AM	† National	
	MM54C02	† National	
	MM74C02	National	
	CD4001B	† RCA	
	CD4001BE	RCA	60
	CD4001UB	† RCA	
	CD4001UBE	RCA	
	HBF4001AE	SGS	
	SCL4001B	† SSS	
	(Continued)		

Function	Device	Source	Line
Gates, OR/NOR (Cont'd)			
Quad 2-Input NOR Gate (Continued)			
	SCL4001BE	SSS	
	CM4001A	† Solitron	
	CM4001AE	Solitron	70
	SW4001AE	SW	
	MM74C02	Teledyne S	
	TF4001A/B	† TI	
	TP4001A/B	TI	
	TF4301A/UB	† TI	
	TP4301A/UB	TI	
	TC4001	Toshiba	
Gates, Miscellaneous			
8-Input Expandable Multifunction Gate			
	CD4048BC	National	80
	CD4048BM	† National	
	CD4048B	† RCA	
	CD4048BE	RCA	
	SCL4402B	† SSS	
	SCL4402BE	SSS	
	CM4048A	† Solitron	
	CM4048AE	Solitron	
Triple Gate (dual 4-input NAND and 2-input OR/NOR)			
	MC14501A	† Motorola	90
	MC14501C	Motorola	
Hex Function Gate			
	MC14572A	† Motorola	
	MC14572C	Motorola	
Dual 5-Input Majority Logic Gate			
	MC14530BA	† Motorola	
	MC14530BC	Motorola	
Latches			
8-bit AND Gated Addressable Latch			
	F4724BC	Fairchild	100
	F4724BM	† Fairchild	
	CD4099BC	National	
	CD4099BM	† National	
	CD4099B	† RCA	
	CD4099BE	RCA	
	TF4099B	† TI	
	TP4099B	TI	
Quad Clocked "D" Latch			
	F4042BC	Fairchild	
	F4042BM	† Fairchild	110
	HD4042B-2	† Harris	
	HD4042B-9	Harris	
	SIL4042B	† Mitel	
	SIL4042BE	Mitel	
	MC14042BA	† Motorola	
	MC14042BC	Motorola	
	CD4042BC	National	
	CD4042BM	† National	
	CD4042B	† RCA	
	CD4042BE	RCA	120
	HBF4042AE	SGS	
	SCL4042B	† SSS	
	SCL4042BE	SSS	
	CM4042A	† Solitron	
	CM4042AE	Solitron	
	TF4042A/B	† TI	
	(Continued)		

Function	Device	Source	Line
Latches (Cont'd)			
Quad Clocked "D" Latch (Continued)			
	TP4042A/B	TI	130
	TC4042	Toshiba	
Quad NAND R/S Latch			
	F4044BC	Fairchild	
	F4044BM	† Fairchild	
	HD4044B-2	† Harris	
	HD4044B-9	Harris	
	SIL4044B	† Mitel	
	SIL4044BE	Mitel	
	MC14044BA	† Motorola	
	MC14044BC	Motorola	140
	CD4044AC	National	
	CD4044AM	† National	
	CD4044A/B	† RCA	
	CD4044A/BE	RCA	
	SCL4044A	† SSS	
	SCL4044AE	SSS	
	CM4044A	† Solitron	
	TF4044A/B	† TI	
	TP4044A/B	TI	
	TC4044	Toshiba	150
Quad NAND Latch			
	TF4376A/B	† TI	
	TP4376A/B	TI	
Quad NOR R/S Latch			
	F4043BC	Fairchild	
	F4043BM	† Fairchild	
	HD4043B-2	† Harris	
	HD4043B-9	Harris	
	SIL4043B	† Mitel	
	SIL4043BE	Mitel	160
	MC14043BA	† Motorola	
	MC14043BC	Motorola	
	CD4043AC	National	
	CD4043AM	† National	
	CD4043B	† RCA	
	CD4043BE	RCA	
	SCL4043A	† SSS	
	SCL4043AE	SSS	
	CM4043A	† Solitron	
	CM4043AE	Solitron	170
	TF4043A/B	† TI	
	TP4043A/B	TI	
	TF4078B	† TI	
	TP4078B	TI	
	TC4043	Toshiba	
Quad NOR Latch			
	TF4377A/B	† TI	
	TP4377A/B	TI	
Dual 4-bit Latch			
	SIL4508B	† Mitel	180
	SIL4508BE	Mitel	
	MC14508A	† Motorola	
	MC14508C	Motorola	
	CD4508B	† RCA	
	CD4508BE	RCA	
	SCL4508B	† SSS	
	SCL4508BE	SSS	
	TC4508	Toshiba	

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—CMOS (Cont'd)

Latches (Cont'd)

Function	Device	Source	Line
Dual 4-bit Addressable Latch			
	F4723BC	Fairchild	
	F4723BM	† Fairchild	
	CD4723BC	National	
	CD4723BM	National	

Memories

For additional information see Master Selection Guide-Memory Sections.

Function	Device	Source	Line
16-bit FIFO (4x4)			10
	CD40105B	† RCA	
	CD40105BE	RCA	
64-bit FIFO (16x4)			
	F4703BC	Fairchild	
	F4703BM	† Fairchild	
64-bit Program Stack (16x4 LIFO)			
	F4706BC	Fairchild	
	F4706BM	† Fairchild	
16-bit Multiport Register File (4x4 Read While Write RAM)			20
	MC14580A	† Motorola	
	MC14580C	Motorola	
	CD40208B	† RCA	
	CD40208BE	RCA	
64-bit CAM (8x8 Content Addressable Memory)			
	SCM5533	† SSS	
1,024-bit PROM (256x4)			
	HM6610	**† Harris (680)**	
	HM6611	**† Harris (680)**	30
	HM6612	† Harris	
32-bit RAM (Direct Word Line Addressing)			
	CD4039A	† RCA	
	CD4039AE	RCA	
	CM4039A	† Solitron	
	CM4039AE	Solitron	
32-bit RAM (Binary Addressing)			
	CD4036A	† RCA	
	CD4036AE	RCA	
	CM4036A	† Solitron	40
	CM4036AE	† Solitron	
64-bit RAM (64x1)			
	MCM14505A	† Motorola	
	MCM14505C	Motorola	
64-bit RAM (16x4)			
	F4725BC	Fairchild	
	F4725BM	† Fairchild	
	HD54C89	† Harris	
	HD74C89	Harris	
	MM54C89	**† National (805)**	50
	MM74C89	**National (805)**	
	SCL5589	† SSS	
64-bit RAM (16x4 clocked RAM, three state output register)			
	F4710BC	Fairchild	
	F4710BM	† Fairchild	
256-bit RAM (256x1)			
	F4720BC	Fairchild	
	F4720BM	† Fairchild	
	HD54C200	† Harris	60

(Continued)

Memories (Cont'd)

Function	Device	Source	Line
256-bit RAM (256x1) (Continued)			
	HD74C200	Harris	
	IM6523	† Intersil	
	MCM14537	† Motorola	
	MM54C200	**† National (808)**	
	MM74C200	**National (808)**	
	CD4061A	† RCA	
	CD40061	RCA	70
	SCM5520	† SSS	
	TC4061	Toshiba	
256-bit RAM (64x4)			
	MCM14552	† Motorola	
	MM54C910	**† National (811)**	
	MM74C910	**National (811)**	
	SCM5555	SSS	
512-bit RAM (512x1)			
	S2222	**AMI (634)**	
	S2222A	**AMI (634)**	80
	2222	Nortec	
	2222A	Nortec	
	SCM5522	SSS	
1,024-bit RAM (128x8)			
	MWS5080	RCA	
1,024-bit RAM (256x4)			
	S5101	**AMI (639)**	
	S5101L	**AMI (639)**	
	F4721BC	Fairchild	
	F4721BM	Fairchild	90
	HM6501	**Harris (675)**	
	HM6551	**Harris (676)**	
	HM6552	Harris	
	HM6561	**Harris (677)**	
	HM6562	**Harris (678)**	
	5101	Intel	
	MM54C920	**† National (814)**	
	MM74C920	**National (814)**	
	MM54C921	**† National (816)**	
	MM74C921	**National (816)**	100
	MWS5040	RCA	
	MWS5540	RCA	
	SCM5501S	† SSS	
	SY5101	Synertek	
	SY5111	Synertek	
	SY5112	Synertek	
	TL5007	Toshiba	
1,024-bit RAM (1.024x1)			
	S6508	**AMI (645)**	
	S6508A	**AMI (645)**	110
	F4736BC	Fairchild	
	F4736BM	† Fairchild	
	HM6508	**Harris (679)**	
	HM6518	**Harris (679)**	
	IM6508	† Intersil	
	IM6518	† Intersil	
	MM54C929	**† National (816)**	
	MM74C929	**National (816)**	
	MM54C930	**† National (816)**	
	MM74C930	**National (816)**	120
	MWS5001	RCA	
	MWS5501	RCA	
	SCM5502S	† SSS	
	TC5016	Toshiba	

(Continued)

Memories (Cont'd)

Function	Device	Source	Line
1,024-bit RAM (1.024x1) (Continued)			
	TC5006	Toshiba	
1,024-bit ROM (256x4)			
	MCM14524	† Motorola	130
	TC5007	Toshiba	
2048-bit ROM (256x8)			
	F4735BC	Fairchild	
	F4735BM	† Fairchild	
2,048-bit ROM (512x8)			
	CDP1832	† RCA	
	CDP1832C	RCA	
12,228-bit ROM(1024x12)			
	HM6312	**Harris (681)**	
	IM6312	Intersil	140

Multiplexers, Digital

See also Interface-Analog Switches

Function	Device	Source	Line
Quad 2-Input Multiplexer			
	F4519BC	Fairchild	
	F4519BM	† Fairchild	
	HD14519B-2	† Harris	
	HD14519B-9	Harris	
	HD54C157	† Harris	
	HD74C157	Harris	
	MC14519BA	† Motorola	150
	MC14519BC	Motorola	
	CD4519BC	National	
	CD4519BM	† National	
	MM54C157	† National	
	MM74C157	National	
	MM74C157	Teledyne S	
	TF4519A/B	† TI	
	TP4519A/B	TI	
Dual 4-Channel Digital Multiplexer			
	F4539BC	Fairchild	160
	F4539BM	† Fairchild	
	MC14539BA	† Motorola	
	MC14539BC	Motorola	
	TC4539	Toshiba	
8-Channel Data Selector			
	F4512BC	Fairchild	
	F4512BM	† Fairchild	
	HD14512B-2	† Harris	
	HD14512B-9	Harris	
	SIL4512B	† Mitel	170
	SIL4512BE	Mitel	
	MC14512A	† Motorola	
	MC14512C	Motorola	
	SCL4512B	† SSS	
	SCL4512BE	SSS	
	TF4512A/B	† TI	
	TP4512A/B	TI	
	TC4512	Toshiba	
8-Channel Digital Multiplexer			
	HD54C151	† Harris	180
	HD74C151	Harris	
	MM54C151	† National	
	MM74C151	National	
	MM74C151	Teledyne S	

† Military Temperature Range (−55°C to 125°C)

IC MASTER

DIGITAL—CMOS (Cont'd)

Function	Device	Source	Line
Multiplexers, Digital (Cont'd)			
Dual 8-Channel Digital Multiplexer			
	TF4321A	† TI	
	TP4321A	TI	
16-Channel Digital Multiplexer			
	MM54C150	† National	
	MM74C150	National	
	TF4320A	† TI	
	TP4320A	TI	
16-Channel Digital Multiplexer, Three-State			10
	MM72C19	† National	
	MM82C19	National	
Multivibrators			
Monostable/Astable Multivibrator			
	F4047BC	Fairchild	
	F4047BM	† Fairchild	
	CD4047B	† RCA	
	CD4047BE	RCA	
	CM4047A	† Solitron	
	CM4047AE	Solitron	20
	TF4047A/B	† TI	
	TP4047A/B	TI	
	TC4047	Toshiba	
Dual Monostable Multivibrator			
	F4528BC	Fairchild	
	F4528BM	† Fairchild	
	HD14528B-2	† Harris	
	HD14528B-9	Harris	
	HD54C221	† Harris	
	HD74C221	Harris	30
	SIL4098B	† Mitel	
	SIL4098BE	Mitel	
	SIL4528B	† Mitel	
	SIL4528BE	Mitel	
	MC14528BA	† Motorola	
	MC14528BC	Motorola	
	MC14538BA	† Motorola	
	MC14538BC	Motorola	
	MM54C221	† National	
	MM74C221	National	40
	CD4098B	† RCA	
	CD4098BE	RCA	
	SCL4528B	† SSS	
	SCL4528BE	SSS	
	TF4528A/B	† TI	
	TP4528A/B	TI	
	TC4528	Toshiba	
Oscillators/Dividers			
Oscillator/Divider (Programmable Timer)			
	MC14541BA	† Motorola	50
	MC14541BC	Motorola	
Oscillator/2^3 Divider (2-5v supplies)			
	7209	Intersil	
Oscillator/2^9 Divider			
	5801	Intel	
	5016	Nortec	
Oscillator/2^{11} to 2^{19} Divider, with duty cycle control			
	MM14451	Motorola	

Function	Device	Source	Line
Oscillators/Dividers (Cont'd)			60
Oscillator/2–13| -2–15| Divider (2-5v supplies)			
	UCN-4105	Sprague	
Oscillator/Divider, Mask Programmable for division by 10,000 to 98,000 (Standard divides 3.579 MHz TV crystal to 60 Hz)			
	MM5369	National	
Oscillator/2^{16} Divider with 2^{13} Output (Supply 1-2v 7038B, 2-5 v 7038A)			70
	7038A	Intersil	
	7038B	Intersil	
Oscillator/2–16| Divider (also 2–16| x 10, Supply 2-5v)			
	7027	Intersil	
Oscillator/2^{13} and 2^{17} Divider (Also 2^{17}x10, 2-5v supplies)			
	7213	Intersil	
Oscillator/2^{16} Divider/Buffer			
	MC14450	Motorola	80
	HBC4700	† SGS	
	HBF4700	SGS	
	UCN-4112	Sprague	
	UCN-4113	Sprague	
	SCL5411	SSS	
Oscillator/2–13| and2–17| Divider (2-3v supplies)			
	UCN-4111	Sprague	
Oscillator/2^{21} Divider/Buffer			
	CD4045A	† RCA	90
	CD4045AE	RCA	
	HBF4045AE	SGS	
	SCL4445B	† SSS	
	SCL4445BE	SSS	
	CM4045A	† Solitron	
	CM4045AE	Solitron	
	UCN-4114	Sprague	
Oscillator/2^{22} Divider (with 1 second and 1 minute pulses using 4.193 MHz crystal, 2-5v supplies)			100
	7213	Intersil	
	MC14452	Motorola	
Oscillator/2^{23} Divider			
	SCL5419	SSS	
Oscillator/2^{24} Divider			
	MC14521BA	† Motorola	
	MC14521BC	Motorola	
Frequency Divider (9-Stage)			
	SCL5425A	SSS	
	SCL5427A	SSS	110
	SCL5437A	SSS	
Divider, divide by 5/6			
	RED5/6	LSI Comp	
Divider, divide by 6			
	D6	LSI Comp	
Divider, divide by 50/60			
	RED50/60	LSI Comp	
Divider, divide by 60			
	D60	LSI Comp	

Function	Device	Source	Line
Oscillators/Dividers (Cont'd)			120
Divider, divide by 3000/3600			
	RED3000/3600	LSI Comp	
Divider, divide by 3600			
	D3600	LSI Comp	
Shift Registers			
4-bit Parallel In/Parallel Out Shift Register			
	F4035BC	Fairchild	
	F4035BM	† Fairchild	
	HD4035B-2	† Harris	130
	HD4035B-9	Harris	
	SIL4035B	† Mitel	
	SIL4035BE	Mitel	
	MC14035BA	† Motorola	
	MC14035BC	Motorola	
	CD4035BC	National	
	CD4035BM	† National	
	CD4035B	† RCA	
	CD4035BE	RCA	
	HBF4035AE	SGS	140
	SCL4035B	† SSS	
	SCL4035BE	SSS	
	CM4035A	† Solitron	
	CM4035AE	Solitron	
	TF4035A/B	† TI	
	TP4035A/B	TI	
	TC4035	Toshiba	
4-bit Parallel Shift Register			
	F40195BC	Fairchild	
	F40195BM	† Fairchild	150
	HD54C195	† Harris	
	HD74C195	Harris	
	MM54C195	† National	
	MM74C195	National	
	MM74C195	Teledyne S	
4-bit Bidirectional Shift Register			
	F40194BC	Fairchild	
	F40194BM	† Fairchild	
	HD54C95	† Harris	
	HD74C95	Harris	160
	MC14194BA	† Motorola	
	MC14194BC	Motorola	
	MM54C95	National	
	MM74C95	† National	
	CD40194B	† RCA	
	CD4019BE	RCA	
	MM74C95	Teledyne S	
4-bit Bidirectional Shift Register, Three-State			
	CD40104B	† RCA	
	CD40104BE	RCA	170
Dual 4-bit Serial In/Parallel Out Shift Register			
	F4015BC	Fairchild	
	F4015BM	† Fairchild	
	HD4015B-2	† Harris	
	HD4015B-9	Harris	
	SIL4015B	† Mitel	
	SIL4015BE	Mitel	
	MC14015BA	† Motorola	
	MC14015BC	Motorola	180
	CD4015AC	National	

(Continued)

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—CMOS (Cont'd)

Shift Registers (Cont'd)

Function	Device	Source	Line
Dual 4-bit Serial In/Parallel Out Shift Register (Continued)			
	CD4015AM	† National	
	CD4015B	† RCA	
	CD4015BE	RCA	
	HBF4015AE	SGS	
	SCL4015B	† SSS	
	SCL4015BE	SSS	
	CM4015A	† Solitron	10
	CM4015AE	Solitron	
	SW4015AE	SW	
	TF4015A/B	† TI	
	TP4015A/B	TI	
	TC4015	Toshiba	
8-bit Synchronous Parallel In/Serial Out Shift Register			
	F4014BC	Fairchild	
	F4014BM	† Fairchild	
	HD4014B-2	† Harris	20
	HD4014B-9	Harris	
	SIL4014B	† Mitel	
	SIL4014BE	Mitel	
	MC14014BA	† Motorola	
	MC14014BC	Motorola	
	CD4014AC	National	
	CD4014AM	† National	
	CD4014B	† RCA	
	CD4014BE	RCA	
	HBF4014AE	SGS	30
	SCL4014B	† SSS	
	SCL4014BE	SSS	
	CM4014A	† Solitron	
	CM4014AE	Solitron	
	TF4014A/B	† TI	
	TP4014A/B	TI	
	TC4014	Toshiba	
8-bit (Asynchronous parallel or synchronous serial operation) Parallel In/Serial Out Shift Register			40
	F4021BC	Fairchild	
	F4021BM	† Fairchild	
	HD4021B-2	† Harris	
	HD4021B-9	Harris	
	SIL4021B	† Mitel	
	SIL4021BE	Mitel	
	MC14021BA	† Motorola	
	MC14021BC	Motorola	
	CD4021AC	National	
	CD4021AM	† National	50
	CD4021B	† RCA	
	CD4021BE	RCA	
	SCL4021B	† SSS	
	SCL4021BE	SSS	
	CM4021A	† Solitron	
	CM4021AE	Solitron	
	SW4021AE	SW	
	TF4021A/B	† TI	
	TP4021A/B	TI	
	TC4021	Toshiba	60
8-bit Serial In/Parallel Out Shift Register			
	HD54C164	† Harris	
	HD74C164	Harris	
	MM54C164	† National	
	MM74C164	National	

(Continued)

Shift Registers (Cont'd)

Function	Device	Source	Line
8-bit Serial In/Parallel Out Shift Register (Continued)			
	MM74C164	Teledyne S	70
8-bit Parallel In/Serial Out Shift Register			
	HD54C165	† Harris	
	HD74C165	Harris	
	MM54C165	† National	
	MM74C165	National	
8-bit Bidirectional Parallel/Serial Input/Output Bus Register			
	F4034BC	Fairchild	
	F4034BM	† Fairchild	
	MC14034BA	† Motorola	80
	MC14034BC	Motorola	
	CD4034BC	National	
	CD4034BM	† National	
	SCL4034B	† SSS	
	SCL4034BE	SSS	
	CM4034A	† Solitron	
	CM4034AE	Solitron	
	CD4034B	† RCA	
	CD4034BE	RCA	
	TC4034	Toshiba	90
8-bit Bus Register, Shift and Store			
	CD4094B	† RCA	
	CD4094BE	RCA	
	SCL4094B	† SSS	
	SCL4094BE	SSS	
18-bit Static Shift Register			
	MS612	Ragen	
18-bit Static Shift Register (4, 5, 8, 9, 10, 12, 13, 14, 16, 17, 18-bits)			
	F4006BC	Fairchild	100
	F4006BM	† Fairchild	
	HD4006B-2	† Harris	
	HD4006B-9	Harris	
	MC14006BA	† Motorola	
	MC14006BC	Motorola	
	CD4006AC	National	
	CD4006AM	† National	
	CD4006B	† RCA	
	CD4006BE	RCA	
	SCL4006B	† SSS	110
	SCL4006BE	SSS	
	CM4006A	† Solitron	
	CM4006AE	Solitron	
Dual 16-bit Static Shift Register			
	HSSR0321	Hughes	
	HSSR0351	Hughes	
32-bit Bidirectional Serial In/Serial Out Shift Register			
	CD40100B	† RCA	
	CD40100BE	RCA	120
64-bit Static Shift Register			
	F4031BC	Fairchild	
	F4031BM	† Fairchild	
	CD4031BC	National	
	CD4031BM	† National	
	CD4031B	† RCA	
	CD4031BE	RCA	

Shift Registers (Cont'd)

Function	Device	Source	Line
Dual 64-bit Static Shift Register			
	MC14517BA	† Motorola	130
	MC14517BC	Motorola	
	SCL4517B	SSS	
128-bit Static Shift Register (16-bit increments)			
	MC14562BA	† Motorola	
	MC14562BC	Motorola	
200-bit Dynamic Shift Register			
	CD4062A	† RCA	
	CD4062AE	RCA	
Quad 64-bit Static Shift Register, Separate Clock			140
	F4731BC	Fairchild	
	F4731BM	† Fairchild	
64-bit Variable Length Shift Register			
	F4557BC	† Fairchild	
	F4557BM	Fairchild	
	MC14557BA	† Motorola	
	MC14557BC	Motorola	
96-bit Variable Length Elastic Shift Register			
	MS618	† Ragen	150
128-bit Static Shift Register, W/Control Logic			
	MS625	† Ragen	

Translators

Function	Device	Source	Line
Quad Voltage Up Level Translator			
	F4104BE	Fairchild	
	F4104BM	† Fairchild	
	MEM4900D	† GI	
	MEM4900P	GI	
	CM4104A	† Solitron	
	CM4104AE	Solitron	160
Quad Level Shifter (low to high voltage)			
	CD40109B	† RCA	
	CD40109BE	RCA	
Hex TTL Buffer (Inverting) (CMOS To TTL)			
	HD54C901	† Harris	
	HD74C901	Harris	
	MM54C901	† National	
	MM74C901	National	
Hex TTL Buffer (Non/Inverting) (CMOS To TTL)			170
	HD54C902	† Harris	
	HD74C902	Harris	
	MM54C902	† National	
	MM74C902	National	
Hex PMOS Buffer (Inverting) (PMOS To CMOS or TTL)			
	HD54C903	† Harris	
	HD74C903	Harris	
	MM54C903	† National	
	MM74C903	National	180
Hex PMOS Buffer (Non-Inverting) (PMOS To CMOS or TTL)			
	HD54C904	† Harris	
	HD74C904	Harris	
	MM54C904	† National	
	MM74C904	National	

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—CMOS (Cont'd)

Translators (Cont'd)

HNIL/HTL is suitable for translation/input protection. See HNIL/HTLsection

Miscellaneous

Function	Device	Source	Line
Phase-Locked Loop	F4046BC	Fairchild	
	F4046BM	† Fairchild	
	SIL4046B	† Mitel	
	SIL4046BE	Mitel	
	MC14046BA	† Motorola	10
	MC14046BC	Motorola	
	CD4046B	† RCA	
	CD4046BE	RCA	
	SCL4046A	† SSS	
	SCL4046AE	SSS	
	SCL4446	SSS	
	TF4046A/B	† TI	
	TP4046A/B	TI	
CMOS Transistor Array (See also 4007 Dual Complementary Pair and Inverter-listed under Buffers/Inverters)	CA3600E	† RCA	20
Hex Contact Bounce Eliminator	MC14490	Motorola	
	MC14490E	† Motorola	
8-bit Priority Encoder	F4532BC	Fairchild	
	F4532BM	† Fairchild	
	MC14532BA	† Motorola	
	MC14532BC	Motorola	30
	CD4532B	† RCA	
	CD4532BE	RCA	
	TC4532	Toshiba	
Binary Rate Multiplier	CD4089BC	National	
	CD4089BM	† National	
	CD4089B	† RCA	
	CD4089BE	RCA	
BCD Rate Multiplier	HD14527B-2	† Harris	40
	HD14527B-9	Harris	
	MC14527BA	† Motorola	
	MC14527BC	Motorola	
	CD4527B	† RCA	
	CD4527BE	RCA	
	SCL4527B	† SSS	
	SCL4527BE	SSS	
Bit Rate Generator	F4702BC	Fairchild	
	F4702BM	† Fairchild	50
	MC14411	Motorola	
Dual Differential Line Driver	HD88C30	Harris	
	MM78C30	† National	
	MM88C30	National	
Quad Single Ended Line Driver	HD88C29	Harris	
	MM78C29	† National	
	MM88C29	National	
Dual Line Receiver	MM78C20	† National	60
	(Continued)		

Function	Device	Source	Line
Miscellaneous (Cont'd)			
Dual Line Receiver (Continued)	MM88C20	National	
Programmable Logic Array (Mask Programmed, see also Memory-PLAs)	HPLA0174	Hughes	
Successive Approximation Register	HD54C905	† Harris	70
	HD74C905	Harris	
	MC14559BA	† Motorola	
	MC14559BC	Motorola	
	MM54C905	† National	
	MM74C905	National	
Successive Approximation Register, Cascadable	MC14549BA	† Motorola	
	MC14549BC	Motorola	
Digital Logic (for 3-1/2 digit A/D Systems)	MC14435	Motorola	80
	MC14435E	† Motorola	
Phase Comparator and Programmable Counters	MC14568BA	† Motorola	
	MC14568BC	Motorola	
Synthesizer (Programmable Divider)	CRC8100	Collins	
Synthesizers, see Linear-Phase Locked Loop Circuits			90
9-bit Parity Generator and Checker	CD40101B	† RCA	
	CD40101BE	RCA	
12-bit Parity Tree	F4531BC	Fairchild	
	F4531BM	† Fairchild	
	MC14531BA	† Motorola	
	MC14531BC	Motorola	
	SCL4531B	SSS	
	TF4531A/B	† TI	100
	TP4531A/B	TI	
Dual Schmitt Trigger	F4583BC	Fairchild	
	F4583BM	† Fairchild	
	MC14583BA	† Motorola	
	MC14583BC	Motorola	
	TC4583	Toshiba	
Quad Schmitt Trigger	HD54C909	† Harris	
	HD74C909	Harris	110
	MM54C909	† National	
	MM74C909	National	
Hex Schmitt Trigger	F40014BC	Fairchild	
	F40014AM	† Fairchild	
	HD14584B-2	† Harris	
	HD14584B-9	Harris	
	HD54C14	† Harris	
	HD54C914	† Harris	
	HD74C14	Harris	120
	HD74C914	Harris	
	MC14584BA	† Motorola	
	MC14584BC	Motorola	
	(Continued)		

Function	Device	Source	Line
Miscellaneous (Cont'd)			
Hex Schmitt Trigger (Continued)	CD40106	National	
	CD40106	† National	
	MM54C14	† National	
	MM74C14	National	130
	MM54C914	† National	
	MM74C914	National	
	TF4304A/B	† TI	
	TP4304A/B	TI	
Quad 2-Input NAND Schmitt Trigger	F4093BC	† Fairchild	
	F4093BM	Fairchild	
	MC14093BA	† Motorola	
	MC14093BC	Motorola	
	CD4093BC	National	140
	CD4093BM	† National	
	CD4093B	† RCA	
	CD4093BE	RCA	
	SCL4093B	† SSS	
	SCL4093BE	SSS	
	TF4093B	† TI	
	TP4093B	TI	
Binary to Phone Pulse Converter	MC14408	Motorola	
	MC14409	Motorola	150
Modem (0-600 bps)	MC14412	Motorola	
Remote Control Transmitter (see also Linear-Consumer Circuits, TV Remote Control)	MC14422	Motorola	
Tone Encoder (4x4 Input, 2 Outputs)	MC14410	Motorola	
2 of 8 Keyboard to Binary Encoder	MC14419	Motorola	
Programmable Timer	MC14536BA	† Motorola	160
	MC14536BC	Motorola	
	MC14541BA	† Motorola	
	MC14541BC	Motorola	
Quad Precision Timer/Driver (Inputs cause outputs to switch state for 100 clock pulses)	MC14415	Motorola	
	MC14415E	† Motorola	
Standardized CMOS Array, to build custom circuits by changing final metalization	MASTERMOS	IMI	170
	MonochipM	Interdesign	
Low voltage CMOS devices (Counters, Display Drivers, Counter-Timers) not usually mixed with 5-20v CMOS logic are listed under Digital-Special			

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—ECL

Function	Device	Source	Line
ECL-10000 Series			
The ECL-10000, 95000, 100K and III-Series are presented as separate groups in that sequence.			
Arithmetic Functions			
Dual High Speed Adder/Subtractor			
	F10180	Fairchild	
	F10580	† Fairchild	
	HD10180	Hitachi	
	MC10180	Motorola	10
	SP10180	Plessey	
	10180	Signetics	
	MC10580	† Motorola	
2-bit Arithmetic Logic Unit/Function Generator			
	MC10182	Motorola	
4-bit Arithmetic Logic Unit/Function Generator			
	F10181	Fairchild	
	F10581	† Fairchild	20
	HD10181	Hitachi	
	MC10181	Motorola	
	MC10581	† Motorola	
	SP10181	Plessey	
	10181	Signetics	
4-bit ALU Slice (Microprocessor)			
	MC10800	Motorola	
2-bit Multiplier, High Speed			
	MC10287	Motorola	
4x2-bit Multiplier			30
	MC10183	Motorola	
Look-ahead Carry Circuit			
	F10179	Fairchild	
	F10579	† Fairchild	
	HD10179	Hitachi	
	MC10179	Motorola	
	MC10579	† Motorola	
	SP10179	Plessey	
	10179	Signetics	
5-bit Comparator			40
	F10166	Fairchild	
	F10566	† Fairchild	
	MC10166	Motorola	
Buffers			
Hex Buffer			
	10188	Signetics	
Hex Inverter			
	10189	Signetics	
Hex Inverter/Buffer			
	MC10195	Motorola	50
Counters, Binary			
4-bit Binary Counter			
	F10016C	Fairchild	
	F10016M	† Fairchild	
	MC10178	Motorola	
	SP10178	Plessey	
	10178	Signetics	

Function	Device	Source	Line
Counters, Binary (Cont'd)			
4-bit Universal Binary Counter			
	F10136	Fairchild	60
	F105136	† Fairchild	
	HD10136	Hitachi	
	MC10136	Motorola	
	MC10536	† Motorola	
	SP10136	Plessey	
	SP10536	† Plessey	
	10136	Signetics	
Counters, Decade			
Bi-Quinary Counter			
	MC10138	Motorola	70
	SP10138	Plessey	
	10138	Signetics	
Decade Counter			
	F10010C	Fairchild	
	F10010M	† Fairchild	
Universal Decade Counter			
	F10137	Fairchild	
	MC10137	Motorola	
	MC10537	† Motorola	
	SP10137	Plessey	80
	SP10537	† Plessey	
	10137	Signetics	
Decoders			
Binary to 1-8 Decoder (High)			
	F10162	Fairchild	
	F10562	† Fairchild	
	HD10162	Hitachi	
	MC10162	Motorola	
	MC10562	† Motorola	
	SP10162	Plessey	90
	10162	Signetics	
Binary to 1-8 Decoder (Low)			
	F10161	Fairchild	
	F10561	† Fairchild	
	HD10161	Hitachi	
	MC10161	Motorola	
	MC10561	† Motorola	
	SP10161	Plessey	
	10161	Signetics	
Dual Binary to 1-4 Decoder (High)			100
	F10172	Fairchild	
	F10572	† Fairchild	
	MC10172	Motorola	
	MC10572	† Motorola	
	SP10172	Plessey	
	10172	Signetics	
Dual Binary to 1-4 Decoder (Low)			
	F10171	Fairchild	
	F10571	† Fairchild	
	MC10171	Motorola	110
	MC10571	† Motorola	
	SP10171	Plessey	
	10171	Signetics	

Function	Device	Source	Line
Drivers			
Dual TTL/MST Bus Driver			
	MC10128	Motorola	
	SP10128	Plessey	
Triple 4-3-3 Input Bus Driver			
	F10123	Fairchild	
	F10523	† Fairchild	120
	MC10123	Motorola	
	10123	Signetics	
Quad Bus Driver			
	F10192	Fairchild	
	10192	Signetics	
Flip-Flops			
Dual "D" Master-Slave Flip-Flop			
	F10131	Fairchild	
	F10231	Fairchild	
	F10531	† Fairchild	130
	F10631	† Fairchild	
	HD10131	Hitachi	
	MC10131	Motorola	
	MC10231	Motorola	
	MC10531	† Motorola	
	MC10631	† Motorola	
	SP10131	Plessey	
	SP10231	Plessey	
	SP10531	† Plessey	
	10131	Signetics	140
	10231	Signetics	
Hex "D" Master-Slave Flip-Flop			
	F10176	Fairchild	
	F10576	† Fairchild	
	MC10176	Motorola	
	MC10576	† Motorola	
	SP10176	Plessey	
	10176	Signetics	
Hex "D" Master-Slave Flip-Flop (With Common Reset)			150
	F10186	Fairchild	
	F10586	† Fairchild	
	MC10186	Motorola	
	10186	Signetics	
Dual "J-$\overline{K}$" Master-Slave Flip-Flop			
	F10135	Fairchild	
	F10535	† Fairchild	
	MC10135	Motorola	
	MC10535	† Motorola	160
	SP10135	Plessey	
	SP10535	† Plessey	
	10135	Signetics	
Gates, AND/NAND			
Hex AND Gate			
	MC10197	Motorola	
Dual 4-Input AND/NAND Gate			
	10108	Signetics	
Quad 2-Input Gate (3 AND, 1 AND/NAND)			
	F10104	Fairchild	170
	F10504	† Fairchild	
	HD10104	Hitachi	
	MC10104	Motorola	
	MC10504	† Motorola	

(Continued)

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—ECL (Cont'd)

Gates, AND/NAND (Cont'd)

Quad 2-Input Gate (3 AND, 1 AND/NAND) (Continued)

Device	Source	Line
SP10104	Plessey	
SP10504	† Plessey	
10104	Signetics	

Gates, Exclusive OR/NOR

Quad Exclusive OR Gate

Device	Source	Line
F10113	Fairchild	
F10513	† Fairchild	10
MC10113	Motorola	
SP10113	Plessey	
10113	Signetics	

Triple 2-Input Exclusive OR/NOR Gate

Device	Source	Line
F10107	Fairchild	
F10507	† Fairchild	
HD10107	Hitachi	
MC10107	Motorola	
MC10507	† Motorola	
SP10107	Plessey	20
SP10507	† Plessey	
10107	Signetics	

Gates, OR/NOR

(Sequence OR, NOR, OR/NOR, Combinations)

Dual 3-Input 3-Output OR Gate (Line Driver)

Device	Source	Line
F10110	Fairchild	
F10210	Fairchild	
F10510	† Fairchild	
F10610	† Fairchild	30
HD10110	Hitachi	
MC10110	Motorola	
MC10210	Motorola	
SP10110	Plessey	
SP102110	Plessey	
10110	Signetics	
10210	Signetics	

Dual 3-Input 3-Output NOR Gate (Line Driver)

Device	Source	Line
F10111	Fairchild	40
F10211	Fairchild	
F10511	† Fairchild	
F10611	† Fairchild	
HD10111	Hitachi	
MC10111	Motorola	
MC10211	Motorola	
DM10111	National	
SP10111	Plessey	
SP10211	Plessey	
10111	Signetics	50
10211	Signetics	

Triple 4-3-3 Input NOR Gate

Device	Source	Line
F10106	Fairchild	
F10506	† Fairchild	
HD10106	Hitachi	
MC10106	Motorola	
MC10506	† Motorola	
DM10106	National	
SP10106	Plessey	
SP10156	† Plessey	60
10106	Signetics	

Gates, OR/NOR (Cont'd)

Quad 3-Input NOR Gate (One Input Common)

Device	Source	Line
F10100	Fairchild	
MC10100	Motorola	
SP10100	Plessey	
10100	Signetics	

Dual 3-Input 3-Output (1 OR, 2 NOR) Gate (Line Driver)

Device	Source	Line
F10212	Fairchild	70
MC10212	Motorola	
DM10112	National	
SP10112	Plessey	
SP10212	Plessey	
10112	Signetics	
10212	Signetics	

Dual 4-5 Input OR/NOR Gate

Device	Source	Line
F10109	Fairchild	
F10509	† Fairchild	80
HD10109	Hitachi	
MC10109	Motorola	
MC10509	† Motorola	
DM10109	National	
SP10109	Plessey	
10109	Signetics	

Triple 2-3-2 Input OR/NOR Gate

Device	Source	Line
F10105	Fairchild	
F10505	† Fairchild	
HD10105	Hitachi	90
MC10105	Motorola	
MC10505	† Motorola	
DM10105	National	
SP10105	Plessey	
SP10505	† Plessey	
10105	Signetics	

Quad 2-Input OR/NOR Gate (One Input Common)

Device	Source	Line
F10101	Fairchild	
F10501	† Fairchild	100
HD10101	Hitachi	
MC10101	Motorola	
MC10501	† Motorola	
SP10101	Plessey	
SP10501	† Plessey	
10101	Signetics	

Quad 2-Input Gate (3 OR, 1 OR/NOR)

Device	Source	Line
F10103	Fairchild	
F10503	† Fairchild	
MC10103	Motorola	110
SP10103	Plessey	
10103	Signetics	

Quad 2-Input Gate (3 NOR, 1 OR/NOR)

Device	Source	Line
F10102	Fairchild	
F10502	† Fairchild	
HD10102	Hitachi	
MC10102	Motorola	
MC10502	† Motorola	
SP10102	Plessey	
SP10502	† Plessey	120
10102	Signetics	

Gates, OR-AND/OR-AND-Invert

4-Wide 4-3-3-3 Input OR-AND Gate

Device	Source	Line
F10119	Fairchild	
F10519	† Fairchild	
HD10119	Hitachi	
MC10119	Motorola	
MC10519	† Motorola	
DM10119	National	
SP10119	Plessey	130
SP10519	† Plessey	
10119	Signetics	

Dual 2-Wide 3-Input OR-AND Gate

Device	Source	Line
F10118	Fairchild	
F10518	† Fairchild	
HD10118	Hitachi	
MC10118	Motorola	
MC10518	† Motorola	
DM10118	National	
SP10118	Plessey	140
SP10518	† Plessey	
10118	Signetics	

4-Wide 3-Input OR-AND/OR-AND-Invert Gate

Device	Source	Line
F10121	Fairchild	
F10521	† Fairchild	
HD10121	Hitachi	
MC10121	Motorola	
MC10521	† Motorola	
DM10121	National	150
SP10121	Plessey	
SP10521	† Plessey	
10121	Signetics	

Dual 2-Wide 2-3 Input OR-AND/OR-AND-Invert Gate

Device	Source	Line
F10117	Fairchild	
F10517	† Fairchild	
HD10117	Hitachi	
MC10117	Motorola	
MC10517	† Motorola	160
DM10117	National	
SP10117	Plessey	
SP10517	† Plessey	
10117	Signetics	

Latches

Dual "D" Clocked Latch

Device	Source	Line
F10130	Fairchild	
F10530	† Fairchild	
HD10130	Hitachi	
MC10130	Motorola	170
MC10530	† Motorola	
SP10130	Plessey	
10130	Signetics	

Quad "D" Latch, Gated Output; Active High Enable

Device	Source	Line
F10133	Fairchild	
F10533	† Fairchild	
HD10133	Hitachi	
MC10133	Motorola	
MC10533	† Motorola	180
SP10533	† Plessey	
10133	Signetics	

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—ECL (Cont'd)

Function	Device	Source	Line
Latches (Cont'd)			
Quad "D" Latch, Gated Output; Active Low Enable			
	F10153	Fairchild	
	F10553	† Fairchild	
	MC10153	Motorola	
Quad Latch, Common Clock, Separate Output Enable			
	F10168	Fairchild	
	F10568	† Fairchild	10
	MC10168	Motorola	
Quint Latch			
	F10175	Fairchild	
	F10575	† Fairchild	
	HD10175	Hitachi	
	MC10175	Motorola	
	MC10575	† Motorola	
	SP10175	Plessey	
	10175	Signetics	
Dual 2 to 1 Multiplexer-Latch, Common Reset			20
	F10132	Fairchild	
	F10532	† Fairchild	
	HD10132	Hitachi	
	MC10132	Motorola	
	10132	Signetics	
Dual 2 to 1 Multiplexer-Latch			
	F10134	Fairchild	
	F10534	† Fairchild	
	HD10134	Hitachi	30
	MC10134	Motorola	
	SP10134	Plessey	
	10134	Signetics	
Quad 2-Input Multiplexer-Latch			
	F10173	Fairchild	
	F10573	† Fairchild	
	MC10173	Motorola	
	10173	Signetics	
	SP10173	Plessey	
Memories			40
For additional information, see Master Selection Guide-Memory sections			
RAM (8x2) Simultaneous Read-Write			
	MCM10143	Motorola	
RAM (16x1)			
	HM2101	Hitachi	
RAM (16x4)			
	F10145AC	Fairchild	
	HD10145	Hitachi	
	MCM10145	Motorola	50
	SP10145	Plessey	
	10145	Signetics	
RAM (64x1)			
	MCM10142	Motorola	
	μPB10142	NEC	
	SP10142	Plessey	
	SN10142	TI	
RAM (64x1) 50 Ohm Drive			
	HD10148	Hitachi	
	MCM10148	Motorola	60
	μPB10148	NEC	
	(Continued)		

Function	Device	Source	Line
Memories (Cont'd)			
RAM (64x1) 50 Ohm Drive (Continued)			
	SP10148	Plessey	
	10148	Signetics	
	SN10148	TI	
RAM (64x1) 90 Ohm Drive			
	MCM10140	Motorola	
	SP10140	Plessey	70
	10140	Signetics	
	SN10140	TI	
RAM (64x1) Read-while-Write			
	10151	Signetics	
RAM (128x1)			
	F10405C	Fairchild	
	MB7047	Fujitsu	
	MCM10147	Motorola	
	SN10147	TI	
RAM (256x1)			80
	F10410C	Fairchild	
	F10411C	Fairchild	
	MBM10410	Fujitsu	
	MB7042	Fujitsu	
	HM2104	Hitachi	
	HM2105	Hitachi	
	MCM10144	Motorola	
	μPB10144	NEC	
	SP10144	Plessey	
	10144	Signetics	90
	RC10144	Raytheon	
	RI10144	Raytheon	
	SN10144	TI	
RAM (1024x1)			
	F10415	Fairchild	
	F10415A	Fairchild	
	F100415A	Fairchild	
	MCM10146	Motorola	
	MCM10415A	Motorola	
	MBM10415	Fujitsu	100
	MBM10415A	Fujitsu	
PROM (32x8)			
	10139	Signetics	
PROM (256x4)			
	F10416	Fairchild	
	HM7615	Harris	
	10149	MMI	
	MCM10149	Motorola	
	10149	Signetics	
Multiplexers			110
8 to 1 Multiplexer			
	F10164	Fairchild	
	F10564	† Fairchild	
	HD10164	Hitachi	
	MC10164	Motorola	
	MC10564	† Motorola	
	SP10164	Plessey	
	10164	Signetics	
	SN10164	TI	
Dual 4 to 1 Multiplexer			120
	F10174	Fairchild	
	F10574	† Fairchild	
	HD10174	Hitachi	
	(Continued)		

Function	Device	Source	Line
Multiplexers (Cont'd)			
Dual 4 to 1 Multiplexer (Continued)			
	MC10174	Motorola	
	SP10174	Plessey	
	10174	Signetics	
	SN10174	TI	130
	MC10574	† Motorola	
Quad 2 to 1 Multiplexer (Non-Inverting)			
	F10158	Fairchild	
	F10558	† Fairchild	
	MC10158	Motorola	
	10158	Signetics	
Quad 2 to 1 Multiplexer (Inverting With Enable)			
	F10159	Fairchild	
	F10559	† Fairchild	140
	MC10159	Motorola	
	10159	Signetics	
Shift Registers			
4-bit Shift Register			
	F10000C	Fairchild	
	F10000M	† Fairchild	
4-bit Universal Shift Register			
	F10141	Fairchild	
	F10541	† Fairchild	
	MC10141	Motorola	150
	MC10541	† Motorola	
	SP10141	Plessey	
	10141	Signetics	
Translators			
Dual ECL to MOS/TTL Translator			
	MC74358	Motorola	
	MC75368	Motorola	
	SN75358	TI	
Triple ECL to NMOS Translator			
	MC10177	Motorola	160
	F10177	Fairchild	
Hex ECL to MST Translator			
	MC10191	Motorola	
	10191	Signetics	
Quad ECL to TTL Translator (Differential Input)			
	F10125	Fairchild	
	F10525	† Fairchild	
	HD10125	Hitachi	
	MC10125	Motorola	170
	MC10525	† Motorola	
	SP10125	Plessey	
	SP10525	† Plessey	
	10125	Signetics	
Quad Differential Receiver/MST to ECL Translator			
	MC10190	Motorola	
	10190	Signetics	
Quad TTL to ECL OR/NOR Translator			
	F10124	Fairchild	180
	F10524	† Fairchild	
	HD10124	Hitachi	
	MC10124	Motorola	
	MC10524	† Motorola	
	(Continued)		

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—ECL (Cont'd)

Function	Device	Source	Line
Translators (Cont'd)			
Quad TTL to ECL OR/NOR Translator (Continued)			
	DM10124	National	
	SP10124	Plessey	
	SP10524	† Plessey	
	10124	Signetics	
Miscellaneous			
Triple Differential Line Receiver			
	F10114	Fairchild	10
	F10116	Fairchild	
	F10514	† Fairchild	
	F10516	† Fairchild	
	HD10116	Hitachi	
	MC10114	Motorola	
	MC10116	Motorola	
	MC10216	Motorola	
	MC10516	† Motorola	
	MC10514	† Motorola	
	MC10616	† Motorola	20
	DM10116	National	
	SP10114	Plessey	
	SP10514	† Plessey	
	SP10216	Plessey	
	SP10116	Plessey	
	SP10516	† Plessey	
	10114	Signetics	
	10116	Signetics	
	10216	Signetics	
Quad Differential Line Receiver			30
	F10115	Fairchild	
	F10515	† Fairchild	
	MC10115	Motorola	
	MC10515	† Motorola	
	DM10115	National	
	SP10115	Plessey	
	SP10515	† Plessey	
	10115	Signetics	
Quad Bus Receiver			
	MC10129	Motorola	40
	SP10129	Plessey	
	10129	Signetics	
Dual Simultaneous Bus Transceiver			
	MC10194	Motorola	
8-Input Priority Encoder			
	F10165	Fairchild	
	F10565	† Fairchild	
	HD10165	Hitachi	
	MC10165	Motorola	
	SP10165	Plessey	50
	10165	Signetics	
9-bit Parity Circuit (2 Carry Inputs)			
	F10170	Fairchild	
	F10570	† Fairchild	
	MC10170	Motorola	
	10170	Signetics	
12-bit Parity Generator/Checker			
	F10160	Fairchild	
	F10560	† Fairchild	
	HD10160	Hitachi	60
	MC10160	Motorola	
	MC10560	† Motorola	
	(Continued)		

Function	Device	Source	Line
Miscellaneous (Cont'd)			
12-bit Parity Generator/Checker (Continued)			
	SP10160	Plessey	
	10160	Signetics	
Error Detection/Correction Circuit			
	MC10163	Motorola	
	MC10193	Motorola	70
Active Terminator			
	F10014	Fairchild	
ECL-95000 Series			
Counters			
Binary Counter			
	F95016	Fairchild	
Decade Counter			
	F95010	Fairchild	
Flip-Flops			
"J-K" Flip-Flop			80
	F95029	Fairchild	
Dual "D" Master-Slave Flip-Flop			
	F95231	Fairchild	
Gates, Exclusive OR/NOR			
Triple 2-Input Exclusive OR/NOR Gate			
	F95107	Fairchild	
Gates, OR/NOR			
Dual 3-Input 3-Output OR Gate (Line Driver)			
	F95110	Fairchild	
Dual 3-Input 3-Output NOR Gate (Line Driver)			90
	F95111	Fairchild	
Triple 4-3-3 Input NOR Gate			
	F95106	Fairchild	
Quad 2-Input NOR (With Enable)			
	F95004	Fairchild	
Dual 4-5 Input OR/NOR Gate			
	F95109	Fairchild	
Dual 4-Input OR/NOR Gate (With Enable)			
	F95002	Fairchild	100
Triple 2-3-2 Input OR/NOR Gate			
	F95105	Fairchild	
Triple 2-Input OR/NOR Gate (With Enable)			
	F95003	Fairchild	
Quad 2-Input Gate (3 OR, 1 OR/NOR)			
	F95103	Fairchild	
Quad 2-Input Gate (3 NOR, 1 OR/NOR)			
	F95102	Fairchild	
Quad 2-Input OR/NOR Gate (One Input Common)			110
	F95101	Fairchild	
Latches			
Dual "D" Clocked Latch			
	F95130	Fairchild	

Function	Device	Source	Line
Shift Registers			
4-bit Shift Register			
	F95000	Fairchild	
Translators			
Quad TTL to ECL OR/NOR Translator			
	F95124	Fairchild	120
Miscellaneous			
Triple Differential Line Receiver			
	F95116	Fairchild	
Quad Differential Line Receiver			
	F95115	Fairchild	
ECL-100K Series			
Arithmetic Functions			
4-bit Binary/Decade Arithmetic Logic Unit			
	F100181	Fairchild	
Look Ahead Carry Circuit			130
	F100179	Fairchild	
9-bit Comparator			
	F100166	Fairchild	
Counters			
Multipurpose Counting Register			
	F100136	Fairchild	
Decoders			
Universal Decoder			
	F100170	Fairchild	
Drivers			140
Quad Driver			
	F100112	Fairchild	
Hex Bus Driver			
	F100123	Fairchild	
Flip-Flops			
Triple D Type			
	F100131	Fairchild	
Hex D Type			
	F100151	Fairchild	
Gates, AND-OR-Invert			150
Triple AND-OR-Invert Gate			
	F100117	Fairchild	
5-Wide AND-OR-Invert Gate			
	F100118	Fairchild	
Gates, Exclusive OR/NOR			
Quintuple Exclusive OR/NOR Gate			
	F100107	Fairchild	
Gates, OR/NOR			
Triple 5-Input OR/NOR Gate			
	F100101	Fairchild	160
Quintuple 2-Input OR/NOR Gate			
	F100102	Fairchild	

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—ECL (Cont'd)

Function	Device	Source	Line
Latches			
Triple D Latch			
	F100130	Fairchild	
Hex D Latch			
	F100150	Fairchild	
Memories			
RAM (16x4 Register File)			
	F100145	Fairchild	
RAM (1024x1)			
	F100415	Fairchild	10
Multiplexers			
16-Input Multiplexer			
	F100164	Fairchild	
Triple 4-Input Multiplexer			
	F100171	Fairchild	
Quad 2-Input Multiplexer with Latch			
	F100155	Fairchild	
Shift Registers			
8-bit Universal Shift Register			
	F100141	Fairchild	20
8-bit Shift Matrix			
	F100158	Fairchild	
Miscellaneous			
Quintuple Line Receiver			
	F100114	Fairchild	
Dual 9-bit Parity Generator/Checker			
	F100160	Fairchild	
Universal Priority Encoder			
	F100165	Fairchild	
ECL-III Series			30
Counters			
Binary Counter			
	MC1654	Motorola	
Divide by 4 Counter (1 GHz)			
	11C05C	Fairchild	
	11C05M	Fairchild	
	MC1699	Motorola	
Divide by 4 Prescaler (1 GHz)			
	MC1697	Motorola	
Bi-Quinary Counter			40
	MC1678	Motorola	
Decade Counter (1 GHz)			
	MC1696	Motorola	
Flip-Flops			
Master-Slave "D" Flip-Flop			
	11C70C	Fairchild	
	MC1670	Motorola	
	SP1670B	Plessey	
	SP1671B	Plessey	
Master-Slave "D" Flip-Flop (UHF Prescaler)			50
	11C06C	Fairchild	
	MC1690	Motorola	
(Continued)			

Function	Device	Source	Line
Flip-Flops (Cont'd)			
Master-Slave "D" Flip-Flop (UHF Prescaler) (Continued)			
	SP1690B	Plessey	
Dual Master-Slave "D" Flip-Flop			
	MC1605	Motorola	
Dual, Clocked "R-S" Flip-Flop			60
	MC1666	Motorola	
	SP1666	Plessey	
	SP1667B	Plessey	
Gates, Exclusive OR/NOR			
Triple 2-Input Exclusive OR Gate			
	MC1672	Motorola	
	SP1672B	Plessey	
	SP1673B	Plessey	
Triple 2-Input Exclusive NOR Gate			
	MC1674	Motorola	70
	SP1674B	Plessey	
	SP1675B	Plessey	
Gates, OR/NOR			
Quad 2-Input OR Gate			
	MC1664	Motorola	
	SP1664B	Plessey	
	SP1665B	Plessey	
Quad 2-Input NOR Gate			
	MC1662	Motorola	
	SP1662B	Plessey	80
	SP1663B	Plessey	
Dual 4-Input OR/NOR Gate			
	MC1660	Motorola	
	SP1660B	Plessey	
	SP1661B	Plessey	
Dual 4-5 Input OR/NOR Gate			
	11C01C	Fairchild	
	MC1603	Motorola	
	MC1688	Motorola	
Triple 2-2-3-Input OR/NOR Gate			90
	MC1602	Motorola	
Quad 2-Input OR/NOR Gate			
	MC1601	Motorola	
Latches			
Dual Clocked Latch			
	MC1668	Motorola	
	SP1668	Plessey	
	SP1669	Plessey	
Multivibrators			
Voltage Controlled Multivibrator			100
	11C58C	Fairchild	
	MC1658	Motorola	
	SP1658	Plessey	
Shift Registers			
4-bit Shift Register			
	MC1694	Motorola	

Function	Device	Source	Line
Miscellaneous			
Dual Analog/Digital Comparator			
	MC1650	Motorola	
	MC1651	Motorola	110
	SP1650B	Plessey	
	SP1651B	Plessey	
Triple Line Receiver			
	MC1604	Motorola	
Quad Line Receiver			
	MC1692	Motorola	
	SP1692B	Plessey	
Voltage Controlled Oscillator			
	MC1648	† Motorola	
	SP1648B	Plessey	120

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—HNIL/HTL

Function	Device	Source	Line
Arithmetic Functions			
4-bit Comparator			
	343A/C	Teledyne S	
	343B/M	† Teledyne S	
Buffers/Inverters			
See also: Gates, Miscellaneous			
Hex Inverter			
	MC680	Motorola	
	MC690	Motorola	
	MC697	Motorola	10
	H118	SGS	
	332A/C	Teledyne S	
	332B/M	† Teledyne S	
Hex Inverter, Open Collector			
	MC681	Motorola	
	MC689	Motorola	
	H112	SGS	
Hex Inverter, Strobed			
	ITT335-1	† ITT	
	ITT335-5	ITT	20
	MC677	Motorola	
	H119	SGS	
	335A/C	Teledyne S	
	335B/M	† Teledyne S	
Hex Inverter, Strobed, Open Collector			
	ITT334-1	† ITT	
	ITT334-5	ITT	
	MC678	Motorola	
	H115	SGS	
	334A/C	Teledyne S	30
	334B/M	† Teledyne S	
Counters			
Binary Counter			
	ITT372-1	† ITT	
	ITT372-5	ITT	
	MC685	Motorola	
	H156	SGS	
	372A/C	Teledyne S	
	372B/M	† Teledyne S	
Binary Up/Down Counter			40
	374A/C	Teledyne S	
	374B/M	† Teledyne S	
Decade Counter			
	ITT371-1	† ITT	
	ITT371-5	ITT	
	MC684	Motorola	
	H157	SGS	
	371A/C	Teledyne S	
	371B/M	† Teledyne S	
Decade Up/Down Counter			50
	373A/C	Teledyne S	
	373B/M	† Teledyne S	
Decoders/Drivers			
BCD to Seven Segment Decoder/Driver			
	383A/C	Teledyne S	
	383B/M	† Teledyne S	
BCD to Decimal Decoder, Open Collector			
	ITT381-1	† ITT	
(Continued)			

Function	Device	Source	Line
Decoders/Drivers (Cont'd)			60
BCD to Decimal Decoder, Open Collector (Continued)			
	ITT381-5	ITT	
	381A/C	Teledyne S	
	381B/M	† Teledyne S	
BCD to Seven Segment Driver, Gas Discharge Driver			
	384A/C	Teledyne S	
	384B/M	† Teledyne S	70
BCD to Decimal Decoder/Lamp Driver, Open Collector			
	ITT380-1	† ITT	
	ITT380-5	ITT	
	380A/C	Teledyne S	
	380B/M	† Teledyne S	
BCD to Decimal Decoder/Driver (for Gas Discharge Display Tubes)			
	MC676	Motorola	
	H158	SGS	80
	382A/C	Teledyne S	
	382B/M	† Teledyne S	
Dual Power AND Driver, Open Collector and Open Emitter			
	MC699	Motorola	
Dual 4-Input AND Driver, Expandable			
	H109	SGS	
Dual 4-Input NAND Line Driver, Expandable			
	MC662	Motorola	
Dual 5-Input Power NAND Driver			90
	301A/C	Teledyne S	
	301B/M	† Teledyne S	
Dual 4-Input NAND Lamp/Relay Driver, Open Collector (to 30 v)			
	MC679	Motorola	
Quad 2-Input Power NAND Driver, Open Collector			
	302A/C	Teledyne S	
	302B/M	† Teledyne S	
Flip-Flops			100
Quad D Flip-Flop			
	ITT370-1	† ITT	
	ITT370-5	ITT	
	370A/C	Teledyne S	
	370B/M	† Teledyne S	
Master-Slave R-S Flip-Flop			
	MC664	Motorola	
Master-Slave J-K or Set-Reset Flip-Flop			
	ITT311-1	† ITT	
	ITT311-5	ITT	110
	311A/C	Teledyne S	
	311B/M	† Teledyne S	
Dual "J-K" Flip-Flop with Preset			
	H110	SGS	
Dual "J-K" Flip-Flop with Preset and Clear			
	H111	SGS	
Dual "J-K" Flip-Flop with Reset			
	MC663	Motorola	

Function	Device	Source	Line
Flip-Flops (Cont'd)			
Dual "J-K" or Set-Reset Flip-Flop			120
	ITT312-1	† ITT	
	ITT312-5	ITT	
	MC688	Motorola	
	312A/C	Teledyne S	
	312B/M	† Teledyne S	
	313A/C	Teledyne S	
	313B/M	† Teledyne S	
Gates, AND/NAND			
Dual 2-Input AND Interface Buffer			
	391	Teledyne S	130
Dual 4-Input AND Interface Buffer			
	390	Teledyne S	
Dual 4-Input NAND Gate			
	MC660	Motorola	
	MC661	Motorola	
Dual 2-Input NAND Interface Buffer			
	392	Teledyne S	
Dual 4-Input NAND Interface Buffer			
	395	Teledyne S	
Dual 4-Input NAND Gate, Expandable			140
	H104	SGS	
	H124	SGS	
	396	Teledyne S	
Dual 5-Input NAND Gate			
	ITT301-1	† ITT	
	ITT301-5	ITT	
	ITT322-1	† ITT	
	ITT322-5	ITT	
	301A/C	Teledyne S	
	301B/M	† Teledyne S	150
	322A/C	Teledyne S	
	322B/M	† Teledyne S	
Triple 3-Input NAND Gate			
	MC670	Motorola	
	MC671	Motorola	
	H103	SGS	
Quad 2-Input NAND Gate			
	ITT303-1	† ITT	
	ITT303-5	ITT	
	ITT321-1	† ITT	160
	ITT321-5	ITT	
	ITT324-1	† ITT	
	ITT324-5	ITT	
	MC668	Motorola	
	MC672	Motorola	
	H102	SGS	
	H122	SGS	
	303A/C	Teledyne S	
	303B/M	† Teledyne S	
	321A/C	Teledyne S	170
	321B/M	† Teledyne S	
	324A/C	Teledyne S	
	324B/M	† Teledyne S	
Quad 2-Input NAND Gate, Open Collector			
	ITT302-1	† ITT	
	ITT302-5	ITT	
	ITT323-1	† ITT	
	ITT323-5	ITT	
(Continued)			

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—HNIL/HTL (Cont'd)

Function	Device	Source	Line
Gates, AND/NAND (Cont'd)			
Quad 2-Input NAND Gate, Open Collector (Continued)			
	302A/C	Teledyne S	
	302B/M	† Teledyne S	
	323A/C	Teledyne S	
	323B/M	† Teledyne S	
Quad 2,2,3,3-Input NAND Gate			
	ITT325-1	† ITT	
	ITT325-5	ITT	10
	ITT326-1	† ITT	
	ITT326-5	ITT	
	325A/C	Teledyne S	
	325B/M	† Teledyne S	
	326A/C	Teledyne S	
	326B/M	Teledyne S	
Gates, OR/NOR			
Dual 2-Input OR Interface Buffer			
	393	Teledyne S	
Dual 2-Input NOR Interface Buffer			20
	394	Teledyne S	
Quad 2-Input NOR Gate			
	306A/C	Teledyne S	
	306B/M	† Teledyne S	
Quad 2-Input NOR Gate, Open Collector			
	307A/C	Teledyne S	
	307B/M	† Teledyne S	
GATES, AND-OR-Invert			
Expandable AND-OR-Invert			
	344A/C	Teledyne S	30
	344B/M	† Teledyne S	
Dual 2-Wide, 2-Input AND-OR-Invert Gate			
	MC673	Motorola	
	MC674	Motorola	
	341A/C	Teledyne S	
	341B/M	† Teledyne S	
Dual 2-Wide, 2-Input AND-OR-Invert Gate, Expandable			
	H105	SGS	
Gates, Exclusive OR			40
Quad 2-Input Exclusive OR Gate			
	MC683	Motorola	
Gates, Miscellaneous			
Hex Inverter/Gate (Quad Inverter, Dual NAND Gate)			
	ITT333-1	† ITT	
	ITT333-5	ITT	
	333A/C	Teledyne S	
	333B/M	† Teledyne S	
Hex Inverter/Gate (Quad Inverter, Dual NAND Gate) Open Collector			50
	ITT332-1	† ITT	
	ITT332-5	ITT	
	332A/C	Teledyne S	
	332B/M	† Teledyne S	
Dual 4-Input Gate Expander (for 600 Series)			
	MC669	Motorola	

Function	Device	Source	Line
Gates, Miscellaneous (Cont'd)			
Dual 5-Input Gate Expander (for 300 Series)			
	331A/C	Teledyne S	60
	331B/M	† Teledyne S	
	CA3094	† RCA	
	CA3094A	† RCA	
	CA3094B	† RCA	
Latches			
Quad Latch			
	MC682	Motorola	
Multiplexers			
8-Bit Multiplexer			
	350A/C	Teledyne S	70
	350B/M	† Teledyne S	
Dual 4-Bit Multiplexer			
	351A/C	Teledyne S	
	351B/M	† Teledyne S	
Multivibrators			
Monostable Multivibrator			
	H117	SGS	
	346	Teledyne S	
Dual Monostable Multivibrator			
	ITT342-1	ITT	80
	ITT342-5	ITT	
	MCC667	Motorola	
	342A/C	Teledyne S	
	342B/M	† Teledyne S	
Dual Retriggerable Monostable Multivibrator			
	347A/C	Teledyne S	
	347B/M	† Teledyne S	
Shift Registers			
4-bit Parallel In Parallel Out Shift Register			
	MC686	Motorola	90
	375A/C	Teledyne S	
	375B/M	† Teledyne S	
Translators			
Dual Low to High Interface (TTL to HNIL)			
	362A/C	Teledyne S	
	362B/M	† Teledyne S	
Triple Low to High Translator (TTL to HTL)			
	MC666	Motorola	
Quad Low to High Interface (TTL to HNIL)			
	H114	SGS	100
	363A/C	Teledyne S	
	363B/M	† Teledyne S	
Dual High to Low Interface (HNIL to DTL, TTL)			
	361A/C	Teledyne S	
	361B/M	† Teledyne S	
Dual Interface Element, (Line Driver, Receiver, ECL to TTL, MOS tottl)			
	MC696	Motorola	
Triple High to Low Translator (HTL to TTL)			110
	MC665	Motorola	
Quad High to Low Converter (Open Collector)			
	H113	SGS	

Function	Device	Source	Line
Translators (Cont'd)			
Hex Inverter/Interface (Low to High: TTL, CMOS to HTL, CMOS)			
	MC691	Motorola	
MISCELLANEOUS			
Pulse Stretcher			120
	348	Teledyne S	
Dual Pulse Stretcher			
	MC675	Motorola	
	349A/C	Teledyne S	
	349B/M	† Teledyne S	
Quad Schmitt Trigger/Line Receiver			
	367A/C	Teledyne S	
	367B/M	† Teledyne S	
Quad Schmitt Trigger/Line Receiver, Open Collector			130
	368A/C	Teledyne S	
	368B/M	† Teledyne S	

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL

Arithmetic Functions

Function	Device	Source	Line
Gated Full Adder			
TTL	5480	† Fairchild	
	7480	Fairchild	
	ITT5480	† ITT	
	ITT7480	ITT	
	MC5480	† Motorola	
	MC7480	Motorola	
	7480	Signetics	
	N8268	Signetics	10
	5480	† Signetics	
	S8268	† Signetics	
	SW7480	SW	
	TL7480	Telefunken	
	SN5480	† TI	
	SN7480	TI	
2-bit Binary Full Adder			
TTL	5482	† Fairchild	
	7482	Fairchild	
	ZN5482	† Ferranti	20
	ZN7482	Ferranti	
	HD2513	Hitachi	
	ITT5482	† ITT	
	ITT7482	ITT	
	SW7482	SW	
	TL7482	Telefunken	
	SN5482	† TI	
	SN7482	TI	
4-bit Binary Full Adder, Look-Ahead Carry			
TTL	5483	† Fairchild	30
	7483	Fairchild	
	54283	† Fairchild	
	74283	Fairchild	
	ZN5483A	† Ferranti	
	ZN7483A	Ferranti	
	HD2535	Hitachi	
	ITT5483	† ITT	
	ITT7483	ITT	
	MC5483	† Motorola	
	MC7483	Motorola	40
	DM5483	† National	
	DM7483	National	
	5483	† Raytheon	
	7483	Raytheon	
	54283	† Raytheon	
	74283	Raytheon	
	7483	Signetics	
	5483	† Signetics	
	SW7483	SW	
	TL7483	Telefunken	50
	TL74283	Telefunken	
	SN5483A	† TI	
	SN7483A	TI	
	SN54283	† TI	
	SN74283	TI	
TTL-LS	9LS83C	Fairchild	
	9LS83M	† Fairchild	
	9LS283C	Fairchild	
	9LS283M	† Fairchild	
	54LS83	† Fairchild	60
	74LS83	Fairchild	
	54LS283	† Fairchild	
	74LS283	Fairchild	
	DM54LS83	† National	

(Continued)

Arithmetic Functions (Cont'd)

Function	Device	Source	Line
4-bit Binary Full Adder, Look-Ahead Carry (Continued)			
	DM74LS83	National	
	DM54LS283	† National	70
	DM74LS283	National	
	9LS83AC	**Raytheon (239)**	
	9LS83AM	**† Raytheon (239)**	
	54LS83A	**† Raytheon (239)**	
	74LS83A	**Raytheon (239)**	
	9LS283C	Raytheon	
	54LS283	† Raytheon	
	9LS283M	† Raytheon	
	74LS283	Raytheon	
	74LS83	Signetics	80
	54LS83	† Signetics	
	74LS283	Signetics	
	54LS283	† Signetics	
	SN54LS83A	† TI	
	SN74LS83A	TI	
	SN54LS283	† TI	
	SN74LS283	TI	
TTL-S	SN54S283	† TI	
	SN74S283	TI	
4-bit Full Adder with Output Latch			90
TTL	AM2506C	AMD	
	AM2506M	† AMD	
NBCD Adder (Natural Binary Coded Decimal)			
TTL	MC54456	† Motorola	
	MC74456	Motorola	
4-bit BCD Adder			
TTL-S	N82S83	Signetics	
Dual Full Adder			
TTL	9304C	AMD	
	9304M	† AMD	100
	9304C	Fairchild	
	9304M	† Fairchild	
	ITT9304-1	† ITT	
	ITT9304-5	ITT	
	MC8304	Motorola	
	MC9304	Motorola	
	RC8304	Raytheon	
	RM9304	† Raytheon	
TTL-H	54H183	† Fairchild	
	74H183	Fairchild	110
	TL74H183	Telefunken	
	SN54H183	† TI	
	SN74H183	TI	
Quad Serial Adder/Subtractor			
TTL-LS	AM25LS15C	AMD	
	AM25LS15M	† AMD	
	SN54LS385	† TI	
	SN74LS385	TI	
4-bit BCD Arithmetic Unit (add, subtract, compare)			120
TTL-S	N82S82	Signetics	
Binary Multiplier (2x4) Parallel, Serial Output			
TTL-LS	74LS261	Signetics	
	9LS261C	**Raytheon (318)**	
	9LS261M	**† Raytheon (318)**	
	54LS261	**† Raytheon (318)**	

(Continued)

Arithmetic Functions (Cont'd)

Function	Device	Source	Line
Binary Multiplier (2x4) Parallel, Serial Output (Continued)			130
	74LS261	**Raytheon (318)**	
	54LS261	† Signetics	
	SN54LS261	† TI	
TTL-S	SN74LS261	TI	
Binary Multiplier (4x2)			
TTL	9344C	Fairchild	
	9344M	† Fairchild	
Binary Multiplier (4x4) Three-State			
TTL-S	SN74S274	TI	
4-bit Multiplier, Three-State (two ICs to a set 7875A and 7875B)			140
TTL	DM7875	† National	
	DM8875	National	
Binary Multiplier (4x4) Parallel (used with 54/74285)			
TTL	DM54284	† National	
	TL74284	Telefunken	
	SN54284	† TI	
	SN74284	TI	
Binary Multiplier (4x4) Parallel (used with 54/74284)			150
TTL	TL74285	Telefunken	
	SN54285	† TI	
	SN74285	TI	
Multiplier (8x1) Serial/Parallel 2's Complement			
TTL-LS	AM25LS14C	AMD	
	AM25LS14M	† AMD	
	SN54LS384	† TI	
	SN74LS384	TI	160
8-Bit Serial/Parallel Register (for use with 25LS14/74LS384			
TTL-LS	AM25LS22C	AMD	
	AM25LS22M	† AMD	
	SN54LS322	TI	
	SN74LS322	TI	
2's Complement Multiplier (4x2)			
TTL	AM2505C	AMD	
	AM2505M	† AMD	
	RC2505	Raytheon	170
	RM2505	† Raytheon	
TTL-S	AM25S05C	AMD	
	AM25S05M	† AMD	
	93S43C	Fairchild	
	93S43M	† Fairchild	
2's Complement Multiplier (8x8)			
	MPY8A	TRW	
2's Complement Multiplier (16x16)			
	MPY16A	TRW	
7-bit Slice Wallace Tree (to build multipliers)			180
TTL-S	SN54S275	† TI	
	SN74S275	TI	
4-bit ALU with Look-ahead Carry			
TTL	9340C	AMD	
	9340M	† AMD	
	9340C	Fairchild	

(Continued)

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Arithmetic Functions (Cont'd)

Function	Device	Source	Line
4-bit ALU with Look-ahead Carry (Continued)			
	9340M	† Fairchild	
Arithmetic Logic Unit/Function Generator			
TTL	9341C	AMD	
	9341M	† AMD	
	AM2506C	AMD	
	AM2506M	† AMD	
	SN54181	† AMD	
	SN74181	AMD	10
	9341C	Fairchild	
	9341M	† Fairchild	
	54181	† Fairchild	
	74181	† Fairchild	
	ZN54181	† Ferranti	
	ZN74181	Ferranti	
	HD2547	Hitachi	
	MC54181	Motorola	
	MC74181	Motorola	
	DM54181	† National	20
	DM74181	National	
	54181	† Raytheon	
	74181	Raytheon	
	RC9341	Raytheon	
	RM9341	† Raytheon	
	74181	Signetics	
	54181	† Signetics	
	SW7481	SW	
	TL74181	Telefunken	
	SN54181	† TI	30
	SN74181	TI	
TTL-LS	AM25LS181C	AMD	
	AM25LS181M	† AMD	
	SN54LS181	† AMD	
	SN74LS181	AMD	
	9LS181C	Fairchild	
	9LS181M	† Fairchild	
	54LS181	† Fairchild	
	74LS181	Fairchild	
	9LS181C	**Raytheon (277)**	40
	9LS181M	**† Raytheon (277)**	
	54LS181	**† Raytheon (277)**	
	74LS181	**Raytheon (277)**	
	25LS181C	**Raytheon (346)**	
	25LS181M	**† Raytheon (346)**	
	74LS181	Signetics	
	54LS181	† Signetics	
	SN54LS181	† TI	
	SN74LS181	TI	
TTL-H	54R181	† Raytheon	50
	74R181	Raytheon	
TTL-S	SN54S181	† AMD	
	SN74S181	AMD	
	54S181	† Fairchild	
	74S181	Fairchild	
	93S41C	Fairchild	
	93S41M	† Fairchild	
	HD74S181	Hitachi	
	74S181	Signetics	
	SN54S181	† TI	60
	SN74S181	TI	
Arithmetic Logic Unit/Function Generator			
TTL-LS	AM25LS2517C	AMD	
	(Continued)		

Arithmetic Functions (Cont'd)

Function	Device	Source	Line
Arithmetic Logic Unit/Function Generator (Continued)			
	AM25LS2517M	AMD	
	AM25LS381C	AMD	
	AM25LS381M	† AMD	70
	SN54LS381	† AMD	
	SN74LS381	AMD	
	54LS381	† TI	
	74LS381	TI	
TTL-S	SN54S381	† TI	
	SN74S381	TI	
Look-ahead Carry Generator			
TTL	9342C	AMD	
	9342M	† AMD	
	SN54182	† AMD	80
	SN74182	AMD	
	9342C	Fairchild	
	9342M	† Fairchild	
	54182	† Fairchild	
	74182	Fairchild	
	HD2562	Hitachi	
	ITT54182	† ITT	
	ITT74182	ITT	
	MC54182	† Motorola	
	MC74182	Motorola	90
	DM54182	† National	
	DM74182	National	
	RC9342	Raytheon	
	RM9342	† Raytheon	
	54182	† Raytheon	
	74182	Raytheon	
	74182	Signetics	
	54182	† Signetics	
	SW74182	SW	
	TL74182	Telefunken	100
	SN54182	† TI	
	SN74182	TI	
TTL-H	54R182	† Raytheon	
	74R182	Raytheon	
TTL-S	54S182	† Fairchild	
	74S182	Fairchild	
	93S42C	Fairchild	
	93S42M	† Fairchild	
	DM74S182	National	
	74S182	Signetics	110
	SN54S182	† TI	
	SN74S182	TI	
Register/Arithmetic Logic Unit			
TTL-LS	AM25LS281C	AMD	
	AM25LS281M	† AMD	
	SN54LS281	† AMD	
	SN74LS281	AMD	
TTL-S	DM74S281	National	
	SN54S281	† TI	
	SN74S281	TI	120
Arithmetic Logic Element			
TTL	MC7260	Motorola	
	MC8260	† Motorola	
	RC8260	Raytheon	
	RM8260	† Raytheon	
	N8260	Signetics	
	S8260	† Signetics	

Arithmetic Functions (Cont'd)

Function	Device	Source	Line
Fast Carry Extender (for 8260)			
TTL	MC7261	Motorola	130
	MC8261	† Motorola	
	RC8261	Raytheon	
	RM8261	† Raytheon	
	N8261	Signetics	
	S8261	† Signetics	
Arithmetic and Logic Shift Matrix, Bit and Byte Masking			
TTL-S	9405AC	Fairchild	
	9405AM	† Fairchild	
4-bit Micro processor Slice (ALU)			140
TTL-S	AM2901C	AMD	
	AM2901M	† AMD	
	9405AC	Fairchild	
	9405AM	† Fairchild	
	5701	† MMI	
	6701	MMI	
	57001	† MMI	
	67001	MMI	
	MC2901	Motorola	
	AM2901C	Raytheon	150
	AM2901M	† Raytheon	
	SN54S481	**† TI (1098)**	
	SN74S481	**TI (1098)**	
4-bit Magnitude Comparator			
TTL	DM7200	† National	
	DM8200	National	
	N8269	Signetics	
	S8269	† Signetics	
4-Bit Magnitude Comparator, Separate A=B Output			160
TTL	9324C	AMD	
	9324M	† AMD	
	5485	† Fairchild	
	7485	Fairchild	
	9324C	Fairchild	
	9324M	† Fairchild	
	ZN5485	† Ferranti	
	ZN7485	Ferranti	
	HD7485	Hitachi	
	MC8324	Motorola	170
	MC9324	† Motorola	
	DM5485	† National	
	DM7485	National	
	7485	Signetics	
	5485	† Signetics	
	9324	Signetics	
	SW7485	SW	
	TL7485	Telefunken	
	SN5485	† TI	
	SN7485	TI	180
	7485	TRW	
TTL-LS	54LS85	† Fairchild	
	74LS85	Fairchild	
	DM54LS85	† National	
	DM74LS85	National	
	9LS85C	**Raytheon (241)**	
	9LS85M	**† Raytheon (241)**	
	54LS85	**† Raytheon (241)**	
	74LS85	**Raytheon (241)**	
	74LS85	Signetics	190
	(Continued)		

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Arithmetic Functions (Cont'd)

Function	Device	Source	Line
4-Bit Magnitude Comparator, Separate A=B Output (Continued)			
	54LS85	† Signetics	
	SN54LS85	† TI	
	SN74LS85	TI	
TTL-S	74S85	Signetics	
	54S85	† Signetics	
	SN54S85	† TI	
	SN74S85	TI	10
Dual 4-bit Magnitude Comparator			
TTL	MC4022	Motorola	
6-bit, Unified Bus Comparator, Active Pull Up			
TTL	DM7131	† National	
	DM8131	National	
6-bit Unified Bus Comparator, Open Collector			
TTL	DM7136	† National	
	DM8136	National	
6-bit Identity Comparator			20
TTL	DM7160	† National	
	DM8160	National	
TTL-S	93S46C	Fairchild	
	93546M	† Fairchild	
6-bit Identity Comparator, Open Collector			
TTL-S	93S47C	Fairchild	
	93S47M	† Fairchild	
10-bit Identity Comparator			
TTL	DM7130	† National	
	DM8130	National	30

Buffers/Inverters

Function	Device	Source	Line
Quad Gated Buffer, Three-State			
TTL	54125	† Fairchild	
	74125	Fairchild	
	HD74125	Hitachi	
	DM7093	† National	
	DM8093	National	
	DM54125	† National	
	DM74125	National	
	74125	Signetics	40
	54125	† Signetics	
	TL74125	Telefunken	
	SN54125	† TI	
	SN54425	† TI	
	SN74125	TI	
	SN74425	TI	
TTL-LS	54LS125	† Fairchild	
	74LS125	Fairchild	
	DM54LS125	† National	
	DM74LS125	National	50
	SN54LS125	† TI	
	SN74LS125	TI	
Quad Gated Buffer, Three-State (Inverted Control)			
TTL	54126	† Fairchild	
	74126	Fairchild	
	HD74126	Hitachi	
	DM7094	† National	
	DM8094	National	
	DM54126	† National	60
	(Continued)		

Buffers/Inverters (Cont'd)

Function	Device	Source	Line
Quad Gated Buffer, Three-State (Inverted Control) (Continued)			
	DM74126	National	
	74126	Signetics	
	54126	† Signetics	
	TL74126	Telefunken	
	SN54126	† TI	
	SN74126	TI	70
	SN54426	† TI	
	SN74426	TI	
TTL-LS	54LS126	† Fairchild	
	74LS126	Fairchild	
	DM54LS126	† National	
	DM74LS126	National	
	SN54LS126	† TI	
	SN74LS126	TI	
Hex Buffer, Three-State			
TTL	DM7095	† National	80
	DM7097	† National	
	DM8095	National	
	DM8097	National	
	DM54365	† National	
	DM74365	National	
	DM54367	† National	
	DM74367	National	
	SN54365	† TI	
	SN54367	† TI	
	SN74365	TI	90
	SN74367	TI	
TTL-LS	54LS365	† Fairchild	
	74LS365	Fairchild	
	54LS367	† Fairchild	
	74LS367	Fairchild	
	9LS365C	**Raytheon (325)**	
	9LS365M	**† Raytheon (325)**	
	54LS365	**† Raytheon (325)**	
	74LS365	**Raytheon (325)**	
	SN54LS365	† TI	100
	SN74LS365	TI	
	SN54LS367	† TI	
	SN74LS367	TI	
TTL-S	MC8T95	Motorola	
	MC8T96	Motorola	
	MC8T97	Motorola	
	MC8T98	Motorola	
	N8T95	Signetics	
	N8T96	Signetics	
	N8T97	Signetics	110
	N8T98	Signetics	
Octal Buffer, Three-State			
TTL-LS	DM71LS95	† National	
	DM71LS97	† National	
	DM81LS95	National	
	DM81LS97	National	
Octal (Dual Quad), Buffer (Driver), Hysteresis, Three-State see Octal Bus Drivers under Miscellaneous			
Hex Inverter			120
TTL	5404	† Fairchild	
	7404	Fairchild	
	9016C	Fairchild	
	9016M	† Fairchild	
	(Continued)		

Buffers/Inverters (Cont'd)

Function	Device	Source	Line
Hex Inverter (Continued)			
	ZN5404	† Ferranti	
	ZN7404	Ferranti	
	HD2522	Hitachi	130
	HD7404	Hitachi	
	ITT5404	† ITT	
	ITT7404	ITT	
	ITT9012	† ITT	
	ITT9016-1	† ITT	
	ITT9016-5	ITT	
	MC5404	† Motorola	
	MC7404	Motorola	
	DM5404	† National	
	DM7404	National	140
	DM9016C	National	
	5404	† Raytheon	
	7404	Raytheon	
	7404	Signetics	
	5404	† Signetics	
	SW7404	SW	
	TL7404N	Telefunken	
	SN5404	† TI	
	SN7404	TI	
	TD3404	Toshiba	150
	7404	TRW	
TTL-LS	9LS04C	Fairchild	
	9LS04M	† Fairchild	
	54LS04	† Fairchild	
	74LS04	Fairchild	
	DM54LS04	† National	
	DM74LS04	National	
	9LS04C	**Raytheon (210)**	
	9LS04M	**† Raytheon (210)**	
	54LS04	**† Raytheon (210)**	160
	74LS04	**Raytheon (210)**	
	74LS04	Signetics	
	54LS04	† Signetics	
	SN54LS04	† TI	
	SN74LS04	TI	
TTL-H	54H04	† Fairchild	
	74H04	Fairchild	
	HD2563	Hitachi	
	ITT54H04	† ITT	
	ITT74H04	ITT	170
	MC3008	Motorola	
	MC3108	† Motorola	
	DM54H04	† National	
	DM74H04	National	
	54H04	† Raytheon	
	54R04	† Raytheon	
	74H04	Raytheon	
	74R04	Raytheon	
	54H04	† Signetics	
	74H04	Signetics	180
	SN54H04	† TI	
	SN74H04	TI	
TTL-S	54S04	† Fairchild	
	74S04	Fairchild	
	9S04AC	Fairchild	
	9S04AM	† Fairchild	
	HD74S04	Hitachi	
	DM74S04	National	
	74S04	Signetics	
	N8T93	Signetics	190
	(Continued)		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL (Cont'd)

Function	Device	Source	Line
Buffers/Inverters (Cont'd)			
Hex Inverter (Continued)			
	54S04	† Signetics	
	SN54S04	† TI	
	SN74S04	TI	
Hex Inverter, Open Collector			
TTL	5405	† Fairchild	
	7405	Fairchild	
	9017C	Fairchild	
	9017M	† Fairchild	10
	ZN5405	Ferranti	
	ZN7405	Ferranti	
	HD2523	Hitachi	
	HD7405	Hitachi	
	ITT5405	† ITT	
	ITT7405	ITT	
	MC5405	† Motorola	
	MC7405	Motorola	
	DM5405	† National	
	DM7405	National	20
	5405	† Raytheon	
	7405	Raytheon	
	7405	Signetics	
	5405	† Signetics	
	SW7405	SW	
	TL7405	Telefunken	
	TL740531	Telefunken	
	TL740533	Telefunken	
	SN5405	† TI	
	SN7405	TI	30
	TD3405	Toshiba	
	7405	TRW	
TTL-LS	9LS05C	Fairchild	
	9LS05M	† Fairchild	
	54LS05	† Fairchild	
	74LS05	Fairchild	
	DM54LS05	† National	
	DM74LS05	National	
	9LS05C	**Raytheon (212)**	
	9LS05M	**† Raytheon (212)**	40
	54LS05	**† Raytheon (212)**	
	74LS05	**Raytheon (212)**	
	74LS05	Signetics	
	54LS05	† Signetics	
	SN54LS05	† TI	
	SN74LS05	TI	
TTL-H	54H05	† Fairchild	
	74H05	Fairchild	
	ITT54H05	† ITT	
	ITT74H05	ITT	50
	MC3009	Motorola	
	MC3109	† Motorola	
	DM54H05	† National	
	DM74H05	National	
	54H05	† Raytheon	
	54R05	† Raytheon	
	74H05	Raytheon	
	74R05	Raytheon	
	54H05	† Signetics	
	74H35	Signetics	60
	SN54H05	† TI	
	SN74H05	TI	
TTL-S	54S05	† Fairchild	
	74S06	Fairchild	
(Continued)			

Function	Device	Source	Line
Buffers/Inverters (Cont'd)			
Hex Inverter, Open Collector (Continued)			
	9S05AC	Fairchild	
	9S05AM	† Fairchild	
	HD74S05	Hitachi	70
	DM74S05	National	
	74S05	Signetics	
	N8T84	Signetics	
	54S05	† Signetics	
	SN54S05	† TI	
	SN74S05	TI	
Hex Inverter, Three-State			
TTL	DM7096	† National	
	DM7098	† National	
	DM8096	National	80
	DM8098	National	
	DM54366	† National	
	DM74366	National	
	DM54368	† National	
	DM74368	National	
	SN54366	† TI	
	SN54368	† TI	
	SN74366	TI	
	SN74368	TI	
TTL-LS	54LS366	† Fairchild	90
	74LS366	Fairchild	
	54LS368	† Fairchild	
	74LS368	Fairchild	
	9LS366C	**Raytheon (325)**	
	9LS368M	**† Raytheon (325)**	
	54LS366	**† Raytheon (325)**	
	74LS366	**Raytheon (325)**	
	SN54LS366	† TI	
	SN74LS366	TI	
	SN54LS368	† TI	100
	SN74LS368	TI	
Octal Inverter, Three-State			
TTL-LS	DM71LS96	† National	
	DM71LS98	† National	
	DM81LS96	National	
	DM81LS98	National	
Octal (Dual Quad) Inverter (Driver) Hysteresis, Three-State See Octal Bus Drivers under Miscellaneous			
Counters, Binary Count Up			110
4-bit Binary Counter, Ripple			
TTL	5493	† Fairchild	
	7493	Fairchild	
	9305C	Fairchild	
	9305M	† Fairchild	
	9356C	Fairchild	
	74293	Fairchild	
	ZN5493	† Ferranti	
	ZN7493	Ferranti	
	HD2520	Hitachi	120
	HD7493	Hitachi	
	ITT5493	† ITT	
	ITT7493	ITT	
	MC5493	† Motorola	
	MC7493	Motorola	
	DM5493	† National	
	DM7493	National	
(Continued)			

Function	Device	Source	Line
Counters, Binary Count Up (Cont'd)			130
4-bit Binary Counter, Ripple (Continued)			
	7493	Signetics	
	SW7493	SW	
	TL7493	Telefunken	
	SN5493A	† TI	
	SN7493A	TI	
	SN54293	† TI	
	SN74293	TI	
	TD3493	Toshiba	
	7493	TRW	140
	74293	TRW	
TTL-LS	9LS93C	Fairchild	
	9LS93M	† Fairchild	
	54LS93	† Fairchild	
	74LS93	Fairchild	
	54LS293	† Fairchild	
	74LS293	Fairchild	
	DM54LS93	† National	
	DM74LS93	National	
	9LS93C	**Raytheon (243)**	150
	9LS93M	**† Raytheon (243)**	
	54LS93	**† Raytheon (243)**	
	74LS93	**Raytheon (243)**	
	74LS93	Signetics	
	54LS93	† Signetics	
	54LS293	† Signetics	
	74LS293	Signetics	
	SN54LS93	† TI	
	SN54LS293	† TI	
	SN74LS93	TI	160
	SN74LS293	TI	
Dual 4-bit Binary Counter, Ripple (Dual 54/7493A)			
TTL	SN54393	† TI	
	SN74393	TI	
TTL-LS	54LS393	† Fairchild	
	74LS393	Fairchild	
	SN54LS393	† TI	
	SN74LS393	TI	
Binary Counter/Latch (Divide-By-2, 4, 8, 16), Preset Input			170
TTL	54177	† Fairchild	
	54197	Fairchild	
	74177	Fairchild	
	74197	Fairchild	
	ZN54197	† Ferranti	
	ZN74197	Ferranti	
	HD2573	Hitachi	
	MC7281	Motorola	
	MC8281	Motorola	180
	MC54177	† Motorola	
	MC74177	Motorola	
	DM7281	† National	
	DM7291	† National	
	DM8281	National	
	DM8291	National	
	DM54197	† National	
	DM74197	National	
	DM54177	† National	
	DM74177	National	190
	RC8281	Raytheon	
	RC8291	Raytheon	
(Continued)			

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Counters, Binary Count Up (Cont'd)

Function	Device	Source	Line
Binary Counter/Latch (Divide-By-2, 4, 8, 16), Preset Input (Continued)			
	RM8281	† Raytheon	
	RM8291	† Raytheon	
	N8281	Signetics	
	N8291	Signetics	
	74177	Signetics	
	54177	† Signetics	10
	74197	Signetics	
	54197	† Signetics	
	S8281	† Signetics	
	S8291	† Signetics	
	TL74177	Telefunken	
	TL74197	Telefunken	
	SN54177	† TI	
	SN54197	† TI	
	SN74177	TI	
	SN74197	TI	20
TTL-LS	9LS197C	Fairchild	
	9LS197M	† Fairchild	
	54LS197	† Fairchild	
	74LS197	Fairchild	
	DM54LS197	† National	
	DM74LS197	National	
	9LS197C	**Raytheon (305)**	
	9LS197M	**† Raytheon (305)**	
	54LS197	**† Raytheon (305)**	
	74LS197	**Raytheon (305)**	30
	54LS197	† Signetics	
	74LS197	Signetics	
	SN54LS197	† TI	
	SN74LS197	TI	
TTL-S	74S197	Signetics	
	N82S91	Signetics	
	SN54S197	† TI	
	SN74S197	TI	
Dual Binary Counter, Synchronous			
TTL	MC54453	† Motorola	40
	MC74453	Motorola	
Binary Counter, Synchronous, Preset Input (Synchronous Clear)			
TTL	SN54163	† AMD	
	SN74163	AMD	
	54163	† Fairchild	
	74163	Fairchild	
	ZN54163	† Ferranti	
	ZN74163	Ferranti	
	HD74163	Hitachi	50
	ITT54163	† ITT	
	ITT74163	ITT	
	DM54163	† National	
	DM74163	National	
	54163	† Raytheon	
	74163	Raytheon	
	74163	Signetics	
	54163	Signetics	
	TL74163	Telefunken	
	SN54163	† TI	60
	SN74163	TI	
	74163	TRW	
TTL-LS	AM25LS163C	AMD	
	AM25LS163M	† AMD	
	(Continued)		

Counters, Binary Count Up (Cont'd)

Function	Device	Source	Line
Binary Counter, Synchronous, Preset Input (Synchronous Clear) (Continued)			
	SN54LS163	† AMD	70
	SN74LS163	AMD	
	9LS163C	Fairchild	
	9LS163M	† Fairchild	
	54LS163	† Fairchild	
	74LS163	Fairchild	
	DM54LS163	† National	
	DM74LS163	National	
	9LS163C	**Raytheon (264)**	
	9LS163M	**† Raytheon (264)**	
	54LS163	**† Raytheon (264)**	80
	74LS163	**Raytheon (264)**	
	25LS163C	**Raytheon (341)**	
	25LS163M	**† Raytheon (341)**	
	74LS163	Signetics	
	54LS163	† Signetics	
	SN54LS163	† TI	
	SN74LS163	TI	
Binary Counter, Synchronous, Preset Input (Asynchronous Clear)			
TTL	SN54161	† AMD	90
	SN74161	AMD	
	9316C	AMD	
	9316M	† AMD	
	9316C	Fairchild	
	9316M	† Fairchild	
	54161	† Fairchild	
	74161	Fairchild	
	ZN54161	† Ferranti	
	ZN74161	Ferranti	
	HD74161	Hitachi	100
	ITT9316	ITT	
	ITT54161	† ITT	
	ITT74161	ITT	
	MC8316	Motorola	
	MC9316	† Motorola	
	DM54161	† National	
	DM74161	National	
	DM8316	† National	
	DM9316	National	
	RC9316	Raytheon	110
	RM9316	† Raytheon	
	54161	† Raytheon	
	74161	Raytheon	
	74161	Signetics	
	54161	† Signetics	
	TL74161	Telefunken	
	SN29316	TI	
	SN39316	† TI	
	SN54161	† TI	
	SN74161	TI	120
	74161	TRW	
TTL-LS	AM25LS161C	AMD	
	AM25LS161M	† AMD	
	SN54LS161	† AMD	
	SN74LS161	AMD	
	9LS161C	Fairchild	
	9LS161M	† Fairchild	
	54LS161	† Fairchild	
	74LS161	Fairchild	
	DM54LS161	† National	130
	(Continued)		

Counters, Binary Count Up (Cont'd)

Function	Device	Source	Line
Binary Counter, Synchronous, Preset Input (Asynchronous Clear) (Continued)			
	DM74LS161	National	
	9LS161C	**Raytheon (264)**	
	9LS161M	**† Raytheon (264)**	
	54LS161	**† Raytheon (264)**	
	74LS161	**Raytheon (264)**	140
	25LS161C	**Raytheon (341)**	
	25LS161M	**† Raytheon (341)**	
	74LS161	Signetics	
	54LS161	† Signetics	
	SN54LS161	† TI	
	SN74LS161	TI	
TTL-S	SN54S161	† AMD	
	SN74S161	AMD	
	93S16C	AMD	
	93S16M	† AMD	150
	93S16C	Fairchild	
	93S16M	† Fairchild	
	SN54S163	† TI	
	SN74S163	TI	
Binary Counter, Synchronous, Preset Input, Low-Power			
TTL	N8293	Signetics	
	S8293	† Signetics	
Binary Counter, Synchronous (both conventional and three state outputs) Preset Input			160
TTL	DM7556	† National	
	DM8556	National	

Counters, Binary, Count Up/Down

Function	Device	Source	Line
Binary Up/Down Counter, Synchronous with mode control			
TTL	N8284	AMD	
	S8284	† AMD	
	AM2501C	AMD	170
	AM2501M	† AMD	
	RC8284	Raytheon	
	RM8284	† Raytheon	
	N8284	Signetics	
	S8284	† Signetics	
Binary Up/Down, Synchronous, Preset Input with Mode Control			
TTL	54191	† Fairchild	
	74191	Fairchild	
	ZN54191	† Ferranti	180
	ZN74191	Ferranti	
	HD74191	Hitachi	
	ITT54191	† ITT	
	ITT74191	ITT	
	DM54191	† National	
	DM74191	National	
	54191	† Raytheon	
	74191	Raytheon	
	54191	† Signetics	
	74191	Signetics	190
	TL74191	Telefunken	
	SN54191	† TI	
	SN74191	TI	
TTL-LS	AM25LS191C	AMD	
	(Continued)		

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Function	Device	Source	Line
Counters, Binary, Count Up/Down (Cont'd)			
Binary Up/Down, Synchronous, Preset Input with Mode Control (Continued)			
	AM25LS191M	† AMD	
	SN54LS191	† AMD	
	SN74LS191	AMD	
	9LS191C	Fairchild	
	9LS191M	† Fairchild	
	54LS191	† Fairchild	10
	74LS191	Fairchild	
	DM54LS191	† National	
	DM74LS191	National	
	9LS191C	**Raytheon (283)**	
	9LS191M	**† Raytheon (283)**	
	54LS191	**† Raytheon (283)**	
	74LS191	**Raytheon (283)**	
	25LS191C	**Raytheon (350)**	
	25LS191M	**† Raytheon (350)**	
	74LS191	Signetics	20
	54LS191	† Signetics	
	SN54LS191	† TI	
	SN74LS191	TI	
Binary Up/Down, Synchronous, Preset Input (2 Clocks)			
TTL	9366C	AMD	
	9366M	† AMD	
	SN54193	† AMD	
	SN74193	AMD	
	9366C	Fairchild	30
	9366M	† Fairchild	
	54193	† Fairchild	
	74193	Fairchild	
	ZN54193	† Ferranti	
	ZN74193	Ferranti	
	HD2542	Hitachi	
	ITT54193	† ITT	
	ITT74193	ITT	
	MC54193	† Motorola	
	MC74193	Motorola	40
	DM7563	† National	
	DM8563	National	
	DM54193	† National	
	DM74193	National	
	RC9366	Raytheon	
	RM9366	† Raytheon	
	54193	† Raytheon	
	74193	Raytheon	
	74193	Signetics	
	54193	† Signetics	50
	SW74193	SW	
	TL74193	Telefunken	
	SN54193	† TI	
	SN74193	TI	
	TD34193	Toshiba	
TTL-LS	AM25LS193C	AMD	
	AM25LS193M	† AMD	
	SN54LS193	† AMD	
	SN74LS193	AMD	
	9LS193C	Fairchild	60
	9LS193M	† Fairchild	
	54LS193	† Fairchild	
	74LS193	Fairchild	
	DM54LS193	† National	
	DM74LS193	National	
	(Continued)		

Function	Device	Source	Line
Counters, Binary, Count Up/Down (Cont'd)			
Binary Up/Down, Synchronous, Preset Input (2 Clocks) (Continued)			70
	9LS193C	**Raytheon (291)**	
	9LS193M	**† Raytheon (291)**	
	54LS193	**† Raytheon (291)**	
	74LS193	**Raytheon (291)**	
	25LS193C	**Raytheon (353)**	
	25LS193M	**† Raytheon (353)**	
	74LS193	Signetics	
	54LS193	Signetics	
	SN54LS193	† TI	
	SN74LS193	TI	80
Binary Up/Down Counter, Synchronous, Preset Input, Mode Control, Look-ahead Carry			
TTL-LS	AM25LS169C	AMD	
	AM25LS169M	† AMD	
	SN54LS169	† AMD	
	SN74LS169	AMD	
	54LS169	† Fairchild	
	74LS169	Fairchild	
	SN54LS169	† TI	90
	SN74LS169	TI	
	DM54LS169	† National	
	DM74LS169	**National (743)**	
TTL-S	SN54S169	† TI	
	SN74S169	TI	
Dual Binary Up/Down Counter, Synchronous, Preset Input			
TTL	MC54455	Motorola	
	MC74455	Motorola	
4-bit Universal Shift Register, Binary Up/Down Counter, Synchronous			100
TTL-S	SN74S291	TI	
Counters, Decade, Count Up			
Decade Counter, Divide-By-2 and By 5			
TTL	9350C	Fairchild	
	9350M	† Fairchild	
	5490	† Fairchild	
	7490	Fairchild	
	74290	Fairchild	
	ZN5490	† Ferranti	110
	ZN7490	Ferranti	
	HD2519	Hitachi	
	HD7490	Hitachi	
	ITT5490	† ITT	
	ITT7490	ITT	
	MC5490	† Motorola	
	MC7490	Motorola	
	DM5490	† National	
	DM7490	National	
	7490	Signetics	120
	5490	† Signetics	
	SW7490	SW	
	TL7490	Telefunken	
	TL7490S1	Telefunken	
	SN54290	† TI	
	SN5490A	† TI	
	SN74290	TI	
	SN7490A	TI	
	TD3490	Toshiba	
	(Continued)		130

Function	Device	Source	Line
Counters, Decade, Count Up (Cont'd)			
Decade Counter, Divide-By-2 and By 5 (Continued)			
	7490	TRW	
	74290	TRW	
TTL-LS	9LS90C	Fairchild	
	9LS90M	† Fairchild	
	54LS90	† Fairchild	
	74LS90	Fairchild	140
	54LS290	† Fairchild	
	74LS290	Fairchild	
	DM54LS90	† National	
	DM74LS90	National	
	9LS90C	**Raytheon (243)**	
	9LS90M	**† Raytheon (243)**	
	54LS90	**† Raytheon (243)**	
	74LS90	**Raytheon (243)**	
	74LS90	Signetics	
	54LS90	† Signetics	150
	74LS290	Signetics	
	54LS290	† Signetics	
	SN54LS90	† TI	
	SN74LS90	TI	
	SN54LS290	† TI	
	SN74LS290	TI	
Decade (Divide-By-2 and Divide-By-5) Counter/Latch, Ripple, Preset Input			
TTL	54176	† Fairchild	
	74176	Fairchild	160
	54196	† Fairchild	
	74196	Fairchild	
	MC7280	† Motorola	
	MC54176	† Motorola	
	MC74176	Motorola	
	DM7280	† National	
	DM7290	† National	
	DM8280	National	
	DM8290	National	
	DM54176	† National	170
	DM54196	† National	
	DM74176	National	
	DM74196	National	
	RC8280	Raytheon	
	RC8290	Raytheon	
	RM8280	† Raytheon	
	RM8290	† Raytheon	
	N8280	Signetics	
	N8290	Signetics	
	74176	Signetics	180
	54176	† Signetics	
	74196	Signetics	
	54196	† Signetics	
	S8280	† Signetics	
	S8290	† Signetics	
	TL74176	Telefunken	
	TL74192	Telefunken	
	SN54176	† TI	
	SN54196	† TI	
	SN74176	TI	190
	SN74196	TI	
TTL-LS	9LS196C	Fairchild	
	9LS196M	† Fairchild	
	54LS196	† Fairchild	
	74LS196	Fairchild	
	(Continued)		

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Counters, Decade, Count Up (Cont'd)

Function	Device	Source	Line
Decade (Divide-By-2 and Divide-By-5) Counter/Latch, Ripple, Preset Input (Continued)			
	DM54LS196	† National	
	DM74LS196	National	
	9LS196C	**Raytheon (305)**	
	9LS196M	**† Raytheon (305)**	
	54LS196	**† Raytheon (305)**	10
	74LS196	**Raytheon (305)**	
	74LS196	† Signetics	
	54LS196	Signetics	
	SN54LS196	† TI	
	SN74LS196	TI	
TTL-S	74S196	Signetics	
	N82S90	Signetics	
	SN54S196	† TI	
	SN74S196	TI	
Decade Counter, Synchronous, Preset Input (Asynchronous Clear)			20
TTL	9310C	AMD	
	9310M	† AMD	
	SN54160	† AMD	
	SN74160	AMD	
	9310C	Fairchild	
	9310M	† Fairchild	
	54160	† Fairchild	
	74160	Fairchild	
	HD74160	Hitachi	30
	ITT54160	† ITT	
	ITT74160	ITT	
	MC8310	Motorola	
	MC9310	Motorola	
	DM54160	† National	
	DM74160	National	
	DM8310	National	
	DM9310	† National	
	54160	† Raytheon	
	74160	Raytheon	40
	RC9310	Raytheon	
	RM9310	† Raytheon	
	74160	Signetics	
	54160	† Signetics	
	TL74160	Telefunken	
	SN29310	TI	
	SN39310	TI	
	SN54160	† TI	
	SN74160	TI	
	74160	TRW	50
TTL-LS	AM25LS160C	AMD	
	AM25LS160M	† AMD	
	SN54LS160	† AMD	
	SN74LS160	AMD	
	9LS160C	Fairchild	
	9LS160M	† Fairchild	
	54LS160	† Fairchild	
	74LS160	Fairchild	
	DM54LS160	† National	
	DM74LS160	National	60
	9LS160C	**Raytheon (264)**	
	9LS160M	**† Raytheon (264)**	
	54LS160	**† Raytheon (264)**	
	74LS160	**Raytheon (264)**	
	25LS160C	**Raytheon (341)**	

(Continued)

Counters, Decade, Count Up (Cont'd)

Function	Device	Source	Line
Decade Counter, Synchronous, Preset Input (Asynchronous Clear) (Continued)			70
	25LS160M	**† Raytheon (341)**	
	74LS160	Signetics	
	54LS160	† Signetics	
	SN54LS160	† TI	
	SN74LS160	TI	
TTL-S	SN54S160	† AMD	
	SN74S160	AMD	
	93S10C	AMD	
	93S10M	† AMD	
	93S10C	Fairchild	80
	93S10M	† Fairchild	
Decade Counter, Synchronous, Preset Input (Synchronous Clear)			
TTL	SN54162	† AMD	
	SN74162	AMD	
	54162	† Fairchild	
	74162	Fairchild	
	HD74162	Hitachi	
	ITT54162	† ITT	
	ITT74162	ITT	90
	DM54162	† National	
	DM74162	National	
	54162	† Raytheon	
	74162	Raytheon	
	74162	Signetics	
	54162	† Signetics	
	TL74162	Telefunken	
	SN54162	† TI	
	SN74162	TI	
	74162	TRW	100
TTL-LS	AM25LS162C	AMD	
	AM25LS162M	† AMD	
	SN54LS162	† AMD	
	SN74LS162	AMD	
	9LS162C	Fairchild	
	9LS162M	† Fairchild	
	54LS162	† Fairchild	
	74LS162	Fairchild	
	DM54LS162	† National	
	DM74LS162	National	110
	9LS162C	**Raytheon (264)**	
	9LS162M	**† Raytheon (264)**	
	54LS162	**† Raytheon (264)**	
	74LS162	**Raytheon (264)**	
	25LS162C	**Raytheon (341)**	
	25LS162M	**† Raytheon (341)**	
	74LS162	Signetics	
	54LS162	† Signetics	
	SN54LS162	† TI	
	SN74LS162	TI	120
TTL-S	SN54S162	† TI	
	SN74S162	TI	
Decade Counter, Synchronous, Preset Input Low-Power			
TTL	N8292	Signetics	
	S8292	† Signetics	
Decade Counter, Synchronous (both conventional and three-state outputs), Preset Inputs			
TTL	DM7555	† National	130

(Continued)

Counters, Decade, Count Up (Cont'd)

Function	Device	Source	Line
Decade Counter, Synchronous (both conventional and three-state outputs), Preset Inputs (Continued)			
	DM8555	National	
Dual Decade Counter, Synchronous			
TTL	MC54452	† Motorola	
	MC74452	Motorola	140
Dual Decade Counter, Ripple (Dual 54/7490A)			
TTL	SN54390	† TI	
	SN54490	† TI	
	SN74390	TI	
	SN74490	TI	
TTL-LS	54LS390	† Fairchild	
	74LS390	Fairchild	
	54LS490	† Fairchild	
	74LS490	Fairchild	150
	SN54LS390	† TI	
	SN74LS390	TI	
	SN54LS490	† TI	
	SN74LS490	TI	

Counters, Decade, Count Up/Down

Decade Up/Down Counter, Synchronous			
TTL	N8285	AMD	
	S8285	† AMD	
	RC8285	Raytheon	160
	RM8285	† Raytheon	
	N8285	Signetics	
	S8285	† Signetics	
Decade Up/Down Counter, Synchronous, Preset, with Mode Control			
TTL	9360C	AMD	
	9360M	† AMD	
	9360C	Fairchild	
	9360M	† Fairchild	
	54190	† Fairchild	170
	74190	Fairchild	
	HD74190	Hitachi	
	ITT54190	† ITT	
	ITT74190	ITT	
	DM54190	† National	
	DM74190	National	
	54190	† Raytheon	
	74190	Raytheon	
	74190	Signetics	
	54190	† Signetics	180
	74190	Telefunken	
	SN54190	† TI	
	SN74190	TI	
TTL-LS	AM25LS190C	AMD	
	AM25LS190M	† AMD	
	SN54LS190	† AMD	
	SN74LS190	AMD	
	9LS190C	Fairchild	
	9LS190M	† Fairchild	
	54LS190	† Fairchild	190
	74LS190	Fairchild	
	DM54LS190	† National	
	DM74LS190	National	
	9LS190C	**Raytheon (283)**	

(Continued)

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL (Cont'd)

Counters, Decade, Count Up/Down (Cont'd)

Function	Device	Source	Line
Decade Up/Down Counter, Synchronous, Preset, with Mode Control (Continued)			
	9LS190M	**† Raytheon (283)**	
	54LS190	**† Raytheon (283)**	
	74LS190	**Raytheon (283)**	
	25LS190C	**Raytheon (350)**	
	25LS190M	**† Raytheon (350)**	
	74LS190	Signetics	10
	54LS190	† Signetics	
	SN54LS190	† TI	
	SN74LS190	TI	
Decade Up/Down Counter, Synchronous, Preset Input (2 clocks)			
TTL	9360C	AMD	
	9360M	† AMD	
	SN54192	† AMD	
	SN74192	AMD	
	54192	† Fairchild	20
	74192	Fairchild	
	ZN54192	† Ferranti	
	ZN74192	Ferranti	
	HD2541	Hitachi	
	ITT54192	† ITT	
	ITT74192	ITT	
	MC54192	† Motorola	
	MC74192	Motorola	
	DM7560	† National	
	DM8560	National	30
	DM54192	† National	
	DM74192	National	
	54192	† Raytheon	
	74192	Raytheon	
	RC9360	Raytheon	
	RM9360	† Raytheon	
	74192	† Signetics	
	54192	Signetics	
	TL74129	Telefunken	
	SN54192	† TI	40
	SN74192	TI	
	TD34192	Toshiba	
TTL-LS	AM25LS192C	AMD	
	AM25LS192M	† AMD	
	SN54LS192	† AMD	
	SN74LS192	AMD	
	9LS192C	Fairchild	
	9LS192M	† Fairchild	
	54LS192	† Fairchild	
	74LS192	Fairchild	50
	DM54LS192	† National	
	DM74LS192	National	
	9LS192C	**Raytheon (291)**	
	9LS192M	**† Raytheon (291)**	
	54LS192	**† Raytheon (291)**	
	74LS192	**Raytheon (291)**	
	25LS192C	**Raytheon (353)**	
	25LS192M	**† Raytheon (353)**	
	54LS192	† Signetics	
	74LS192	Signetics	60
	SN54LS192	† TI	
	SN74LS192	TI	
Dual Decade Up/Down Counter, Synchronous, Preset Input			
TTL	MC54454	Motorola	
	(Continued)		

Counters, Decade, Count Up/Down (Cont'd)

Function	Device	Source	Line
Dual Decade Up/Down Counter, Synchronous, Preset Input (Continued)			70
	MC74454	Motorola	
Decade Up/Down Counter, Counter, Synchronous, Preset Input, Mode Control, Look-ahead Carry			
TTL-LS	AM25LS168C	AMD	
	AM25LS168M	† AMD	
	SN54LS168	† AMD	
	SN74LS168	AMD	
	54LS168	† Fairchild	
	74LS168	Fairchild	80
	DM54LS168	National	
	DM74LS168	National	
	SN54LS168	† TI	
	SN74LS168	TI	
TTL-S	SN54S168	† TI	
	SN74S168	TI	
Four Decade Counter/Latch/Display Driver (Synchronous, BCD and segment drives)			
TTL	ZN1040E	Ferranti	

Counters, Miscellaneous

Function	Device	Source	Line
4-bit Universal Counter			90
TTL	MC4023	Motorola	
Divide-By-12 Counter (Divide-By-2 and Divide-By-6), Ripple			
TTL	5492	† Fairchild	
	7492	Fairchild	
	ZN5492	† Ferranti	
	ZN7492	Ferranti	
	HD2521	Hitachi	
	HD7492	Hitachi	100
	ITT5492	† ITT	
	ITT7492	ITT	
	MC5492	† Motorola	
	MC7492	Motorola	
	DM5492	† National	
	DM7492	National	
	7492	Signetics	
	5492	† Signetics	
	SW7492	SW	
	TL7492	Telefunken	110
	SN5492A	† TI	
	SN7492A	TI	
	TD3492	Toshiba	
	7492	TRW	
TTL-LS	54LS92	† Fairchild	
	74LS92	Fairchild	
	DM54LS92	† National	
	DM74LS92	National	
	9LS92C	**Raytheon (243)**	
	9LS92M	**† Raytheon (243)**	120
	54LS92	**† Raytheon (243)**	
	74LS92	**Raytheon (243)**	
	74LS92	Signetics	
	54LS92	† Signetics	
	SN54LS92	† TI	
	SN74LS92	TI	
Divide-By-12 (Divide by 2 and 6) Counter, Preset Input			
TTL	DM7288	† National	
	(Continued)		130

Counters, Miscellaneous (Cont'd)

Function	Device	Source	Line
Divide-By-12 (Divide by 2 and 6) Counter, Preset Input (Continued)			
	DM8288	National	
	N8288	Signetics	
	S8288	† Signetics	
Programmable Modulo-N Binary Counter			
TTL	MC4018	Motorola	
	MC4019	Motorola	140
	MC4318	† Motorola	
	MC4319	† Motorola	
Programmable Modulo-N Decade Counter			
TTL	MC4016	Motorola	
	MC4017	Motorola	
	MC4316	† Motorola	
	MC4317	† Motorola	
Binary Counter/Latch, Three-State			
TTL	DM7554	† National	
	DM8554	National	150
Decade Counter/Latch, Three-State			
TTL	DM7552	† National	
	DM8552	National	
Programmable Modulo-N Divider (Divide by 2 to 15, Cascadable)			
TTL	DM7520	† National	
	DM8520	National	
4-bit Variable Modulo Counter (2 and 5, 6, 7, 8, or 10, 12, 14, 16)			
TTL	9305C	Fairchild	160
	9305M	† Fairchild	
TTL-S	93S05C	Fairchild	
	93S05M	† Fairchild	
Decade Counter/Latch/7 Segment Decoder			
TTL	MC4050	Motorola	
	MC4051	Motorola	
	MC4350	† Motorola	
Decade Counter/Latch/Decoder (Nixie Driver)			
TTL	TL74142	Telefunken	
	SN7412	TI	170
Decade Counter/Latch LED/Lamp Driver (High Current Output)			
TTL	TL7414	Telefunken	
	SN54144	† TI	
	SN74144	TI	
Decade Counter/Latch, LED/Lamp Driver (Constant Current Output)			
TTL	SN54143	† TI	
	TL74143	Telefunken	
	SN74173	TI	180

Decoders

Function	Device	Source	Line
Excess 3-to-Decimal (1 of 10) Decoder			
TTL	5443	† Fairchild	
	7443	Fairchild	
	HD2537	Hitachi	
	HD7443	Hitachi	
	ITT5443	† ITT	
	ITT7443	ITT	
	MC5443	† Motorola	
	(Continued)		190

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Decoders (Cont'd)

Function	Device	Source	Line
Excess 3-to-Decimal (1 of 10) Decoder (Continued)			
	MC7443	Motorola	
	5443	† Raytheon	
	7443	Raytheon	
	7443	Signetics	
	5443	† Signetics	
	SW7443	SW	
	TL7443	Telefunken	10
	SN5443A	† TI	
	SN7443A	TI	
TTL-LS	**9LS43C**	**Raytheon (227)**	
	9LS43M	**† Raytheon (227)**	
	54LS43	**† Raytheon (227)**	
	74LS43	**Raytheon (227)**	
Excess 3 Gray-to-Decimal (1 of 10) Decoder			
TTL	5444	† Fairchild	
	7444	Fairchild	
	HD2538	Hitachi	20
	HD7444	Hitachi	
	ITT5444	† ITT	
	ITT7444	ITT	
	MC5444	† Motorola	
	MC7444	Motorola	
	5444	† Raytheon	
	7444	Raytheon	
	5444	† Signetics	
	7444	Signetics	
	SW7444	SW	30
	TL74145	Telefunken	
	SN5444A	† TI	
	SN7444A	TI	
TTL-LS	**9LS44C**	**Raytheon (227)**	
	9LS44M	**† Raytheon (227)**	
	54LS44	**† Raytheon (227)**	
	74LS44	**Raytheon (227)**	
BCD-to-Decimal (1 of 10) Decoder			
TTL	9301M	† AMD	
	9301C	AMD	40
	5442	† Fairchild	
	7442	Fairchild	
	9301C	Fairchild	
	9301M	† Fairchild	
	9302C	Fairchild	
	9302M	† Fairchild	
	ZN5442	† Ferranti	
	ZN7442	Ferranti	
	HD2536	Hitachi	
	HD7442	Hitachi	50
	ITT5442	† ITT	
	ITT7442	ITT	
	ITT9301-1	† ITT	
	ITT9301-5	ITT	
	MC5442	† Motorola	
	MC7442	Motorola	
	MC8301	Motorola	
	MC9301	† Motorola	
	DM5442	† National	
	DM7442	National	60
	DM8301	National	
	DM9301	† National	
	5442	† Raytheon	
	7442	Raytheon	

(Continued)

Decoders (Cont'd)

Function	Device	Source	Line
BCD-to-Decimal (1 of 10) Decoder (Continued)			
	RC8251	Raytheon	
	RC8252	Raytheon	70
	RM8251	† Raytheon	
	RM8252	† Raytheon	
	7442	Signetics	
	N8251	Signetics	
	N8252	Signetics	
	N9301	Signetics	
	5442	† Signetics	
	S8251	† Signetics	
	S8252	† Signetics	
	SW7442	SW	80
	TL7442	Telefunken	
	SN29301	TI	
	SN39301	† TI	
	SN5442A	† TI	
	SN7442A	TI	
	TD3441	Toshiba	
	TD3442	Toshiba	
TTL-LS	9LS42C	Fairchild	
	9LS42M	† Fairchild	
	54LS42	† Fairchild	90
	74LS42	Fairchild	
	DM54LS42	† National	
	DM74LS42	National	
	9LS42C	**Raytheon (227)**	
	9LS42M	**† Raytheon (227)**	
	54LS42	**† Raytheon (227)**	
	74LS42	**Raytheon (227)**	
	74LS42	Signetics	
	54LS42	† Signetics	
	SN54LS42	† TI	100
	SN74LS42	TI	
TTL-S	N82S52	Signetics	
BCD-to-Binary and Binary-to-BCD Converter, Open Collector			
TTL	MC4001	Motorola	
BCD-to-Decimal Decoder/Driver, Open Collector, 15v			
TTL	54145	† Fairchild	
	74145	Fairchild	
	93145C	Fairchild	110
	93145M	† Fairchild	
	HD2555	† Hitachi	
	ITT54145	† ITT	
	ITT74145	ITT	
	MC54145	† Motorola	
	MC74145	Motorola	
	DM54145	† National	
	DM74145	National	
	54145	† Raytheon	
	74145	Raytheon	120
	74145	Signetics	
	54145	† Signetics	
	SW74145	SW	
	TL74145	Telefunken	
	SN54145	† TI	
	SN74145	TI	
	74145	TRW	
TTL-LS	74LS145	Signetics	
	54LS145	† Signetics	

(Continued)

Decoders (Cont'd)

Function	Device	Source	Line
BCD-to-Decimal Decoder/Driver, Open Collector, 15v (Continued)			
	SN54LS145	† TI	
	SN74LS145	TI	
BCD-to-Decimal/Decoder Driver, Open Collector to 30v Output			
TTL	5445	† Fairchild	
	7445	Fairchild	
	HD2531	Hitachi	140
	ITT5445	† ITT	
	ITT7445	ITT	
	MC5445	† Motorola	
	MC7445	Motorola	
	DM5445	† National	
	DM7445	National	
	5445	† Raytheon	
	7445	Raytheon	
	7445	Signetics	
	5445	† Signetics	150
	SW7445	SW	
	TL7445	Telefunken	
	SN5445	† TI	
	SN7445	TI	
	7445	TRW	
Dual 1-of-4 Decoder/Demultiplexer (Independent Address)			
TTL	9321C	AMD	
	9321M	† AMD	
	9321C	Fairchild	160
	9321M	† Fairchild	
Dual Binary to One-Of-Four Line Gated Decoder			
TTL	MC4007	Motorola	
	MC4307	† Motorola	
Demultiplexer, (2-Lines In-2 of 4 Out) Three-State			
TTL	DM7230	† National	
	DM8230	National	
Dual 2-Line To 4-Line Decoder/ Demultiplexer, Totem Pole Output (or 3-Line to 8-Line Decoder/Demultiplexer)			170
TTL	54155	† Fairchild	
	74155	Fairchild	
	ZN54155	† Ferranti	
	ZN74155	Ferranti	
	HD75155	Hitachi	
	ITT54155	† ITT	
	ITT74155	ITT	
	MC54155	† Motorola	180
	MC74155	Motorola	
	DM54155	† National	
	DM74155	National	
	54155	† Raytheon	
	74155	Raytheon	
	74155	Signetics	
	54155	† Signetics	
	SW74155	SW	
	TL74155	Telefunken	
	SN54155	† TI	190
	SN74155	TI	
	74155	TRW	
TTL-LS	9LS155C	Fairchild	
	9LS155M	† Fairchild	

(Continued)

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL (Cont'd)

Decoders (Cont'd)

Dual 2-Line To 4-Line Decoder/ Demultiplexer, Totem Pole Output (or 3-Line to 8-Line Decoder/Demultiplexer) (Continued)

Function	Device	Source	Line
	54LS155	† Fairchild	
	74LS155	Fairchild	
	DM54LS155	† National	
	DM74LS155	National	
	9LS155C	**Raytheon (260)**	
	9LS155M	**† Raytheon (260)**	10
	54LS155	**† Raytheon (260)**	
	74LS155	**Raytheon (260)**	
	SN54LS155	† TI	
	SN74LS155	TI	

Dual 2-Line to 4-Line Decoder/Demultiplexer, Open Collector (or 3-Line to 8-Line Decoder/ Demultiplexer)

Function	Device	Source	Line
TTL	54156	† Fairchild	
	74156	Fairchild	
	HD74156	Hitachi	20
	ITT54156	† ITT	
	ITT74156	ITT	
	MC54156	† Motorola	
	MC74156	Motorola	
	DM54156	† National	
	DM74156	National	
	54156	† Raytheon	
	74156	Raytheon	
	74156	Signetics	
	54156	† Signetics	30
	SW74156	SW	
	TL74156	Telefunken	
	SN54156	† TI	
	SN74156	TI	
	74156	TRW	
TTL-LS	9LS156C	Fairchild	
	9LS156M	† Fairchild	
	54LS156	† Fairchild	
	74LS156	Fairchild	
	DM54LS156	† National	40
	DM74LS156	National	
	9LS156C	**Raytheon (260)**	
	9LS156M	**† Raytheon (260)**	
	54LS156	**† Raytheon (260)**	
	74LS156	**Raytheon (260)**	
	SN54LS156	† TI	
	SN74LS156	TI	

Dual 2-Line to 4-Line Decoder/Demultiplexer

Function	Device	Source	Line
TTL-LS	AM25LS139C	AMD	
	AM25LS139M	AMD	50
	SN54LS139	† AMD	
	SN74LS139	AMD	
	9LS139C	Fairchild	
	9LS139M	† Fairchild	
	54LS139	† Fairchild	
	74LS139	Fairchild	
	DM54LS139	† National	
	DM74LS139	National	
	9LS139C	**Raytheon (254)**	
	9LS139M	**† Raytheon (254)**	60
	54LS139	**† Raytheon (254)**	
	74LS139	**Raytheon (254)**	
	25LS139C	**Raytheon (332)**	
	25LS139M	**† Raytheon (332)**	
	74LS139	Signetics	

(Continued)

Decoders (Cont'd)

Dual 2-Line to 4-Line Decoder/Demultiplexer (Continued)

Function	Device	Source	Line
	54LS139	† Signetics	70
	SN54LS139	† TI	
	SN74LS139	TI	
TTL-S	93S21C	AMD	
	93S21M	† AMD	
	SN54S139	† AMD	
	SN74S139	AMD	
	54S139	† Fairchild	
	74S139	Fairchild	
	DM74S139	National	
	74S139	Signetics	80
	SN54S139	† TI	
	SN74S139	TI	

3-Line to 8-Line Decoder/Demultiplexer with Input Latches

Function	Device	Source	Line
TTL-S	93S137C	Fairchild	
	93S137M	† Fairchild	

3-Line to 8-Line Decoder/Demultiplexer

Function	Device	Source	Line
TTL-LS	AM25LS138C	AMD	
	AM25LS138M	AMD	
	SN54LS138	† AMD	90
	SN74LS138	AMD	
	9LS138C	Fairchild	
	9LS138M	† Fairchild	
	54LS138	† Fairchild	
	74LS138	Fairchild	
	DM54LS138	† National	
	DM74LS138	National	
	9LS138C	**Raytheon (254)**	
	9LS138M	**† Raytheon (254)**	
	54LS138	**† Raytheon (254)**	100
	74LS138	**Raytheon (254)**	
	25LS138C	**Raytheon (330)**	
	25LS138M	**† Raytheon (330)**	
	74LS138	Signetics	
	54LS138	† Signetics	
	SN54LS138	† TI	
	SN74LS138	TI	
TTL-S	SN54S138	† AMD	
	SN74S138	AMD	
	54S138	† Fairchild	110
	74S138	Fairchild	
	3205	Intel	
	DM74S138	National	
	74S138	† Signetics	
	SN54S138	† TI	
	SN74S138	TI	

Dual 2-Line to 4-Line Decoder/Demultiplexer (or 3-Line to 8-Line Decoder/Demultiplexer) Three-State

Function	Device	Source	Line
	54255	† Raytheon	120
	74255	Raytheon	
TTL-LS	**9LS255C**	**Raytheon (313)**	
	9LS255M	**† Raytheon (313)**	
	54LS255	**† Raytheon (313)**	
	74LS255	**Raytheon (313)**	

Binary to Octal (1 of 8) Decoder

Function	Device	Source	Line
TTL	9301C	Fairchild	
	9301M	† Fairchild	
	MC4006	Motorola	

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Decoders (Cont'd)

Binary to Octal (1 of 8) Decoder (Continued)

Function	Device	Source	Line
	MC4306	† Motorola	
	MC7250	Motorola	
	MC8250	† Motorola	
	RC8250	Raytheon	
	RM8250	† Raytheon	
	N8250	Signetics	
	S8250	† Signetics	
TTL-S	N82S50	Signetics	140

Binary to Octal Decoder, Non-Inverting

Function	Device	Source	Line
TTL	MC4048	Motorola	

Binary to Octal Decoder, Inverting/Non-Inverting, Open Collector

Function	Device	Source	Line
TTL	MC4038	Motorola	

1-Line to 8-Line Demultiplexer

Function	Device	Source	Line
TTL	DM7223	† National	
	DM8223	National	

Binary to 2-of-8 Decoder, Open Collector

Function	Device	Source	Line
TTL	MC4040	Motorola	150

4-Line to 16-Line Decoder/Demultiplexer

Function	Device	Source	Line
TTL	9311C	AMD	
	9311M	† AMD	
	SN54154	† AMD	
	SN74154	AMD	
	9311C	Fairchild	
	9311M	† Fairchild	
	54154	† Fairchild	
	74154	Fairchild	
	ZN54154	† Ferranti	160
	ZN74154	Ferranti	
	HD2580	Hitachi	
	ITT9311-1	† ITT	
	ITT9311-5	ITT	
	ITT54154	† ITT	
	ITT74154	ITT	
	MC8311	Motorola	
	MC9311	† Motorola	
	DM54154	† National	
	DM74154	National	170
	DM8311	National	
	DM9311	† National	
	RC9311	Raytheon	
	RM9311	† Raytheon	
	54154	† Raytheon	
	74154	Raytheon	
	74154	Signetics	
	54154	† Signetics	
	SW74154	SW	
	TL74154	Telefunken	180
	SN29311	TI	
	SN39311	† TI	
	SN54154	† TI	
	SN74154	TI	
	74154	TRW	
TTL-LS	DM54LS154	† National	
	DM74LS154	National	

4-Line to 16-Line Decoder/Demultiplexer, Open Collector Output

Function	Device	Source	Line
TTL	54159	† Raytheon	190
	74159	Raytheon	
	SN54159	† TI	

(Continued)

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Function	Device	Source	Line
Decoders (Cont'd)			
4-Line to 16-Line Decoder/Demultiplexer, Open Collector Output (Continued)			
	SN74159	TI	
Drivers			
Quad Predriver, Open Collector			
TTL	MC4042	Motorola	
Quad Driver, Common Enable Active Pull-Up (sinks to 120ma)			
TTL	IM5001	Intersil	10
	IM5001M	† Intersil	
	IM5011	Intersil	
	IM5011M	† Intersil	
Quad 2-Input AND Buffer, Open Collector, to 15v Output (High Voltage 54/74109)			
TTL	ITT54131	† ITT	
	ITT74131	ITT	
	DS7819	† National	
	DS8819	National	
Hex Buffer/Driver, Open Collector High Voltage Output, to 15v			20
TTL	5417	† Fairchild	
	7417	Fairchild	
	HD7417	Hitachi	
	ITT5417	† ITT	
	ITT7417	ITT	
	MC5417	† Motorola	
	MC7417	Motorola	
	DM5417	† National	
	DM7417	National	30
	7417	Signetics	
	5417	† Signetics	
	SW7417	SW	
	TL7417	Telefunken	
	SN5417	† TI	
	SN7417	TI	
	TD3417	Toshiba	
	7417	TRW	
Hex Buffer/Driver, Open Collector High Voltage Output, to 30v			40
TTL	5407	† Fairchild	
	7407	Fairchild	
	HD7407	Hitachi	
	ITT5407	† ITT	
	ITT7407	ITT	
	MC5407	† Motorola	
	MC7407	Motorola	
	DM5407	† National	
	DM7407	National	
	7407	Signetics	50
	5407	† Signetics	
	SW7407	SW	
	TL7407	Telefunken	
	SN5407	† TI	
	SN7407	TI	
	TD3407	Toshiba	
	7407	TRW	
Hex Inverter Buffer/Driver Open Collector High Voltage Output, to 15v			
TTL	5416	† Fairchild	60
	7416	Fairchild	
	HD7416	Hitachi	
(Continued)			

Function	Device	Source	Line
Drivers (Cont'd)			
Hex Inverter Buffer/Driver Open Collector High Voltage Output, to 15v (Continued)			
	ITT5416	† ITT	
	ITT7416	ITT	
	MC5416	† Motorola	
	MC7416	Motorola	70
	DM5416	† National	
	DM7416	National	
	DS7812	† National	
	DS8812	National	
	7416	Signetics	
	5416	† Signetics	
	SW7416	SW	
	TL7416	Telefunken	
	SN5416	† TI	
	SN7416	TI	80
	TD3416	Toshiba	
	7416	TRW	
Hex Inverter Buffer/Driver, Open Collector High Voltage Output, to 30v			
TTL	5406	† Fairchild	
	7406	Fairchild	
	HD7406	Hitachi	
	ITT5406	† ITT	
	ITT7406	ITT	
	MC5406	† Motorola	90
	MC7406	Motorola	
	DM5406	† National	
	DM7406	National	
	7406	Signetics	
	5406	† Signetics	
	SW7406	SW	
	TL7406	Telefunken	
	SN5406	† TI	
	SN7406	TI	
	TD3406	Toshiba	100
	7406	TRW	
Hex High Voltage Interface Driver, Open Collector, to 35v			
TTL	HD235	† Harris	
	HD535	Harris	
Quad 2-Input AND Buffer, Open Collector, to 30v Output			
TTL	ITT54130	† ITT	
	ITT74130	ITT	
Quad 2-Input NAND Buffer, Open Collector, to 15v Output			110
TTL	5426	† Fairchild	
	7426	Fairchild	
	HD2560	Hitachi	
	HD7426	Hitachi	
	ITT5426	† ITT	
	ITT7426	ITT	
	MC5426	† Motorola	
	MC7426	Motorola	
	DM5426	† National	120
	DM7426	National	
	DS7810	† National	
	DS7811	† National	
	DS8810	National	
	DS8811	National	
	7426	Signetics	
	5426	† Signetics	
(Continued)			

Function	Device	Source	Line
Drivers (Cont'd)			
Quad 2-Input NAND Buffer, Open Collector, to 15v Output (Continued)			130
	SW7426	SW	
	TL7426	Telefunken	
	SN5426	† TI	
	SN7426	TI	
	TD3426	Toshiba	
	7426	TRW	
Quad 2-Input NAND Buffer, Open Collector, to 30v Output			
TTL	N8T80	Signetics	140
	S8T80	† Signetics	
Quad 2-Input OR Buffer, Open Collector, to 15v Output			
TTL	ITT54139	† ITT	
	ITT74139	ITT	
Quad 2-Input OR Buffer, Open Collector, to 30v Output			
TTL	ITT54138	† ITT	
	ITT74138	ITT	
4-Input NAND High Voltage, High Current Driver (40 to 50v, sinks 150 to 500ma)			150
TTL	SH2001C	Fairchild	
	SH2001M	† Fairchild	
	SH2002C	Fairchild	
	SH2002M	† Fairchild	
	SH2200C	Fairchild	
	SH2200M	† Fairchild	
Quad 2-Input AND Power Driver, Open Collector (to 100v, sinks 250ma)			
TTL	UHC/D-400	† Sprague	160
	UHC/D-406	† Sprague	
	UHC/D-500	† Sprague	
	UHC/D-506	† Sprague	
	UHP-400	Sprague	
	UHP-406	Sprague	
	UHP-500	Sprague	
	UHP-506	Sprague	
Quad 2-Input NAND Power Driver, Open Collector (to 100v, sinks 250ma)			
TTL	UHC/D-407	† Sprague	170
	UHC/D-408	† Sprague	
	UHC/D-507	† Sprague	
	UHC/D-508	† Sprague	
	UHP-407	Sprague	
	UHP-408	Sprague	
	UHP-507	Sprague	
	UHP-508	Sprague	
Quad 2-Input NAND Bus Driver, Open Collector, 80ma			
TTL	96101	Fairchild	180
Quad 2-Input OR Power Driver, Open Collector (to 100v, sinks 250ma)			
TTL	UHC/D-402	† Sprague	
	UHC/D-403	† Sprague	
	UHC/D-502	† Sprague	
	UHC/D-503	† Sprague	
	UHP-402	Sprague	
	UHP-403	Sprague	
	UHP-502	Sprague	
	UHP-503	Sprague	190

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL (Cont'd)

Function	Device	Source	Line
Drivers (Cont'd)			
Quad 2-Input NOR Power Driver, Open Collector (to 100v, sinks 250ma)			
TTL	UHC/D-432	† Sprague	
	UHC/D-433	† Sprague	
	UHC/D-532	† Sprague	
	UHC/D-533	† Sprague	
	UHP-432	Sprague	
	UHP-433	Sprague	
	UHP-532	Sprague	10
	UHP-533	Sprague	
Quad 2-Input NOR 75-Ohm/50-Ohm Line Driver			
TTL	74128	Signetics	
	TL74128	Telefunken	
	SN54128	† TI	
	SN74128	TI	
Hex Interface Inverter, Open Collector, to 50v or to 50ma)			
TTL	HD234	† Harris	20
	HD334	† Harris	
	HD534	Harris	
Quad Bus Driver, Three-State			
TTL	RC8T09	Raytheon	
	RM8T09	† Raytheon	
	N8T09	Signetics	
	S8T09	† Signetics	
Hex Bus Driver, Gated Enable, Three-State			
TTL	DM54365	† National	
	DM74365	National	30
	SN54365	† TI	
	SN74365	TI	
Hex Bus Driver, Gated Enable, Inverted Three-State Output			
TTL	DM54366	† National	
	DM74366	National	
	SN54366	† TI	
	SN74366	TI	
Hex Bus Driver, 2-Line and 4-Line Enable, Three-State			40
TTL	DM54367	† National	
	DM74367	National	
	SN54367	† TI	
	SN74367	TI	
Hex Bus Driver, 2-Line and 4-Line Enable, Inverted Three-State Output			
TTL	DM54368	† National	
	DM74368	National	
	SN54368	† TI	
	SN74368	TI	50
Dual 3-Input 3-Output AND Series Terminated Line Driver			
TTL-H	MC3028	Motorola	
	MC3128	† Motorola	
Dual 3-Input 3-Output NAND Series Terminated Line Driver			
TTL-H	MC3029	Motorola	
	MC3129	† Motorola	
Dual 4-Input Positive NAND 50 Ohm Line Driver			60
TTL-S	54S140	† Fairchild	
	(Continued)		

Function	Device	Source	Line
Drivers (Cont'd)			
Dual 4-Input Positive NAND 50 Ohm Line Driver (Continued)			
	74S140	† Fairchild	
	HD74S140	Hitachi	
	DM74S140	National	
	74S140	Signetics	
	SN54S140	† TI	70
	SN74S140	TI	
Flip-Flops			
J-K Master-Slave Flip-Flop			
TTL	9000C	Fairchild	
	9000M	† Fairchild	
	9001C	Fairchild	
	9001M	† Fairchild	
	54104	† Fairchild	
	54105	† Fairchild	
	74104	Fairchild	80
	74105	Fairchild	
	ITT9001	ITT	
	SW74104	SW	
	TL74104	Telefunken	
	TL74105	Telefunken	
AND Gated J-K Master-Slave Flip-Flop with Preset and Clear			
TTL	5472	† Fairchild	
	7472	Fairchild	
	ZN5472	† Ferranti	90
	ZN7472	Ferranti	
	HD2529	Hitachi	
	HD7472	Hitachi	
	ITT5472	† ITT	
	ITT7472	ITT	
	MC5472	† Motorola	
	MC7472	Motorola	
	DM5472	† National	
	DM7472	National	
	7472	Signetics	100
	5472	† Signetics	
	SW7472	SW	
	TL7472	Telefunken	
	SN5472	† TI	
	SN7472	TI	
	TD3472	Toshiba	
	7472	TRW	
TTL-H	54H72	† Fairchild	
	74H72	Fairchild	
	ITT54H72	† ITT	110
	ITT74H72	ITT	
	MC3050	Motorola	
	MC3051	Motorola	
	MC3055	Motorola	
	MC3150	† Motorola	
	MC3151	† Motorola	
	MC3155	† Motorola	
	DM54H72	† National	
	DM74H72	National	
	54H72	† Signetics	120
	74H72	Signetics	
	SN54H72	† TI	
	SN74H72	TI	
AND Gated J-K Master-Slave Flip-Flop with Data Lockout			
TTL	TL74110	Telefunken	
	(Continued)		

Function	Device	Source	Line
Flip-Flops (Cont'd)			
AND Gated J-K Master-Slave Flip-Flop with Data Lockout (Continued)			130
	SN54110	† TI	
	SN74110	TI	
AND Gated, Edge-Triggered J-K Flip-Flop with Preset and Clear			
TTL	5470	† Fairchild	
	7470	Fairchild	
	ZN5470	† Ferranti	
	ZN7470	Ferranti	
	HD2539	Hitachi	
	ITT5470	† ITT	140
	ITT7470	ITT	
	MC5470	† Motorola	
	MC7470	Motorola	
	DM5470	† National	
	DM7470	National	
	7470	Signetics	
	N8270	Signetics	
	S8270	† Signetics	
	SW7470	SW	
	TL7470	Telefunken	150
	SN5470	† TI	
	SN7470	TI	
J-K Negative Edge-Triggered Flip-Flop, AND Input			
TTL-H	54H102	† Fairchild	
	74H102	Fairchild	
	54H102	† Signetics	
	74H102	Signetics	
	SN54H102	† TI	
	SN74H102	TI	160
J-K Master-Slave Flip-Flop, AND-OR Input			
TTL-H	54H71	† Fairchild	
	74H71	Fairchild	
	MC3054	Motorola	
	MC3154	† Motorola	
	DM54H71	† National	
	DM74H71	National	
	54H71	† Signetics	
	74H71	Signetics	
	SN54H71	† TI	170
	SN74H71	TI	
J-K Negative Edge-Triggered Flip-Flop, AND-OR Input			
TTL-H	54H101	† Fairchild	
	74H101	Fairchild	
	54H101	† Signetics	
	74H101	Signetics	
	SN54H101	† TI	
	SN74H101	TI	
Dual J-K Negative Edge-Triggered Flip-Flop, with Clear			180
TTL-H	54H103	† Fairchild	
	74H103	Fairchild	
	DM54H103	† National	
	DM74H103	National	
	54H103	† Signetics	
	74H103	Signetics	
	SN54H103	† TI	
	SN74H103	TI	

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Flip-Flops (Cont'd)

Function	Device	Source	Line
Dual J-K Negative Edge-Triggered Flip-Flop, Preset, Common Clear, Common Clock			
TTL-H	54H108	† Fairchild	
	74H108	Fairchild	
	DM54H108	† National	
	DM74H108	National	
	54R114	† Raytheon	
	74R114	Raytheon	
	54H108	† Signetics	10
	74H108	Signetics	
	SN54H108	† TI	
	SN74H108	TI	
D Type Double Edge-Triggered Master-Slave Flip-Flop			
TTL-H	MC3053	Motorola	
	MC3153	† Motorola	
AND Input $\overline{JJ}$-$\overline{KK}$ Flip-Flop			22
ITT-H	MC3052	Motorola	
	MC3152	† Motorola	
Negative Edge-Triggered Flip-Flop with Common Clock and Common Clear			
TTL-S	54S114	† Fairchild	
	74S114	Fairchild	
	HD74S114	Hitachi	
	DM74S114	National	30
	74S114	Signetics	
	SN54S114	† TI	
	SN74S114	TI	
Dual "J-$\overline{K}$" Flip-Flop with Preset, Common Clock and Common Clear			
TTL-LS	DM54LS78	† National	
	DM74LS78	National	
	9LS78C	**Raytheon (237)**	
	9LS78M	**† Raytheon (237)**	40
	54LS78	**Raytheon (237)**	
	74LS78	**Raytheon (237)**	
	74LS78	Signetics	
	54LS78	† Signetics	
	54LS78	† Signetics	
	SN54LS78	† TI	
	SN74LS78	TI	
TTL-H	54H78	† Fairchild	
	74H78	Fairchild	
	DM54H78	† National	50
	DM74H78	National	
	SN54H78	† TI	
	SN74H78	TI	
Dual J-$\overline{K}$ Positive Edge-Triggered Flip-Flop, Preset and Clear			
TTL	9024C	Fairchild	
	9024M	† Fairchild	
	74109	Fairchild	
	ITT9024-1	† ITT	60
	ITT9024-5	ITT	
	DM54109	† National	
	DM74109	National	
	74109	Signetics	
	54109	† Signetics	
	SN54109	† TI	
	SN74109	TI	
TTL-LS	9LS109C	Fairchild	
	9LS109M	† Fairchild	
	(Continued)		70

Flip-Flops (Cont'd)

Function	Device	Source	Line
Dual J-K Positive Edge-Triggered Flip-Flop, Preset and Clear (Continued)			
	54LS109	† Fairchild	
	74LS109	Fairchild	
	DM54LS109	† National	
	DM74LS109	National	
	9LS109C	**Raytheon (251)**	
	9LS109M	**† Raytheon (251)**	
	54LS109	**† Raytheon (251)**	80
	74LS109	**Raytheon (251)**	
	54LS109	† Signetics	
	74LS109	Signetics	
	SN54LS109	† TI	
	SN74LS109	TI	
TTL-S	54S109	† Fairchild	
	74S109	Fairchild	
Dual J-K Negative Edge-Triggered Flip-Flop, Separate Preset and Clock, (no Clear)			
TTL-LS	9LS113C	Fairchild	90
	9LS113M	† Fairchild	
	54LS113	† Fairchild	
	74LS113	Fairchild	
	DM54LS113	† National	
	DM74LS113	National	
	9LS113C	**Raytheon (232)**	
	9LS113M	**† Raytheon (232)**	
	54LS113	**† Raytheon (232)**	
	74LS113	**Raytheon (232)**	
	74LS113	Signetics	100
	54LS113	† Signetics	
	SN54LS113	† TI	
	SN74LS113	TI	
TTL-S	54S113	† Fairchild	
	74S113	Fairchild	
	HD74S113	Hitachi	
	DM74S113	National	
	74S113	Signetics	
	SN54S113	† TI	
	SN74S113	TI	110
TTL-H	54R113	† Raytheon	
	74R113	Raytheon	
Dual "J-K" Negative Edge-Triggered Flip-Flop with Preset, Common Clock and Common Clear			
TTL-LS	9LS114C	Fairchild	
	9LS114M	† Fairchild	
	54LS114	† Fairchild	
	74LS114	Fairchild	
	DM54LS114	† National	120
	DM74LS114	National	
	9LS114C	**Raytheon (237)**	
	9LS114M	**† Raytheon (237)**	
	54LS114	**† Raytheon (237)**	
	74LS114	**Raytheon (237)**	
	74LS114	Signetics	
	54LS114	† Signetics	
	SN54LS114	† TI	
	SN74LS114	TI	
Dual "J-K" Negative Edge-Triggered Flip-Flop with Preset and Clear			130
TTL-LS	9LS112C	Fairchild	
	9LS112M	† Fairchild	
	54LS112	† Fairchild	
	(Continued)		

Flip-Flops (Cont'd)

Function	Device	Source	Line
Dual "J-K" Negative Edge-Triggered Flip-Flop with Preset and Clear (Continued)			
	74LS112	Fairchild	
	DM54LS112	† National	140
	DM74LS112	National	
	9LS112C	**Raytheon (232)**	
	9LS112M	**† Raytheon (232)**	
	54LS112	**† Raytheon (232)**	
	74LS112	**Raytheon (232)**	
	74LS112	Signetics	
	54LS112	Signetics	
	SN54LS112	† TI	
	SN74LS112	TI	
TTL-S	54S112	† Fairchild	150
	74S112	Fairchild	
	HD74S112	Hitachi	
	DM74S112	National	
	74S112	Signetics	
	SN54S112	† TI	
	SN74S112	TI	
TTL-H	54H106	† Fairchild	
	74H106	Fairchild	
	DM54H106	† National	
	DM74H106	National	160
	54R112	† Raytheon	
	74R112	Raytheon	
	54H106	† Signetics	
	74H106	Signetics	
	SN54H106	† TI	
	SN74H106	TI	
Dual J-K Master-Slave Flip-Flop			
TTL	9020C	Fairchild	
	9020M	† Fairchild	
	ITT9020-1	† ITT	170
	ITT9020-5	ITT	
Dual J-K Master-Slave Flip-Flop with Clear			
TTL	5473	† Fairchild	
	7473	Fairchild	
	54107	† Fairchild	
	74107	Fairchild	
	ZN5473	† Ferranti	
	ZN7473	Ferranti	
	ZN54107	† Ferranti	
	ZN74107	Ferranti	180
	HD2515	Hitachi	
	HD2530	Hitachi	
	HD74107	Hitachi	
	ITT5473	† ITT	
	ITT7473	ITT	
	ITT54107	† ITT	
	ITT74107	ITT	
	MC5473	† Motorola	
	MC7473	Motorola	
	MC54107	† Motorola	190
	MC74107	Motorola	
	DM5473	† National	
	DM7473	National	
	DM54107	† National	
	DM74107	National	
	7473	Signetics	
	74107	Signetics	
	5473	† Signetics	
	54107	† Signetics	
	(Continued)		200

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL (Cont'd)

Flip-Flops (Cont'd)

Function	Device	Source	Line
Dual J-K Master-Slave Flip-Flop with Clear (Continued)			
	SW7473	SW	
	TL7473	Telefunken	
	TL74107	Telefunken	
	SN5473	† TI	
	SN7473	† TI	
	SN54107	† TI	
	SN74107	TI	10
	TD3473	Toshiba	
	TD34107	Toshiba	
TTL-LS	9LS73C	Fairchild	
	9LS73M	† Fairchild	
	54LS73	† Fairchild	
	74LS73	Fairchild	
	54LS107	† Fairchild	
	74LS107	Fairchild	
	DM54LS73	† National	
	DM74LS73	National	20
	DM54LS107	† National	
	DM74LS107	National	
	9LS73C	**Raytheon (232)**	
	9LS73M	**† Raytheon (232)**	
	74LS73	**Raytheon (232)**	
	54LS73	**† Raytheon (232)**	
	9LS107C	**Raytheon (232)**	
	9LS107M	**† Raytheon (232)**	
	54LS107	**† Raytheon (232)**	
	74LS107	**Raytheon (232)**	30
	74LS73	Signetics	
	74LS107	Signetics	
	54LS73	† Signetics	
	54LS107	† Signetics	
	SN54LS73	† TI	
	SN74LS73	TI	
	SN54LS107	† TI	
	SN74LS107	TI	
TTL-H	54H73	† Fairchild	
	74H73	Fairchild	40
	ITT54H73	† ITT	
	ITT74H73	ITT	
	MC3061	Motorola	
	MC3062	Motorola	
	MC3063	Motorola	
	MC3161	† Motorola	
	MC3162	† Motorola	
	MC3163	† Motorola	
	DM54H73	† National	
	DM74H73	National	50
	54H73	† Signetics	
	74H73	Signetics	
	SN54H73	† TI	
	SN74H73	TI	
Dual J-K Master-Slave Flip-Flop with Preset and Clear			
TTL	5476	† Fairchild	
	7476	Fairchild	
	9022C	Fairchild	
	9022M	† Fairchild	60
	ZN5476	† Ferranti	
	ZN7476	Ferranti	
	HD2516	Hitachi	
	ITT5476	† ITT	
	ITT7476	ITT	
	(Continued)		

Flip-Flops (Cont'd)

Function	Device	Source	Line
Dual J-K Master-Slave Flip-Flop with Preset and Clear (Continued)			
	ITT9022-1	ITT	70
	ITT9022-5	ITT	
	MC5476	† Motorola	
	MC7476	Motorola	
	DM5476	† National	
	DM7476	National	
	7476	Signetics	
	5476	† Signetics	
	SW7476	SW	
	TL7476	Telefunken	
	SN5476	† TI	80
	SN7476	TI	
	TD3476	Toshiba	
	7476	TRW	
TTL-LS	DM54LS76	† National	
	DM74LS76	National	
	9LS76C	**Raytheon (232)**	
	9LS76M	**† Raytheon (232)**	
	54LS76	**† Raytheon (232)**	
	74LS76	**Raytheon (232)**	
	74LS76	Signetics	90
	54LS76	† Signetics	
	SN54LS76	† TI	
	SN74LS76	TI	
TTL-H	54H76	† Fairchild	
	74H76	Fairchild	
	ITT54H76	† ITT	
	ITT74H76	ITT	
	DM54H76	† National	
	DM74H76	National	
	74H76	Signetics	100
	54H76	† Signetics	
	SN54H76	† TI	
	SN74H76	TI	
Dual J-K Master-Slave Flip-Flop with Data Lockout			
TTL	TL74111	Telefunken	
	SN74376	TI	
	SN74111	TI	
	74111	TRW	
Dual Gated Master-Slave J-K/D Flip-Flop			110
TTL	DM7512	† National	
	DM8512	National	
Dual J-K Master/Slave Flip-Flop with Data Lockout and Clear			
TTL	TL74115	Telefunken	
Quad J-&K Edge-Triggered Flip-Flop with Clear			
TTL	SN54376	† TI	
	SN74376	TI	
Quad J-&K Edge-Triggered Flip-Flop with Preset and Clear			120
TTL	SN74276	TI	
Dual D-Type Flip-Flop			
TTL	MC5479	† Motorola	
	MC7479	Motorola	
Dual D-Type Positive Edge-Triggered Flip-Flop with Preset and Clear			
TTL	5474	† Fairchild	
	(Continued)		

Flip-Flops (Cont'd)

Function	Device	Source	Line
			130
Dual D-Type Positive Edge-Triggered Flip-Flop with Preset and Clear (Continued)			
	7474	Fairchild	
	ZN5474	† Ferranti	
	ZN7474	Ferranti	
	HD2510	Hitachi	
	HD7474	Hitachi	
	ITT5474	† ITT	
	ITT7474	ITT	140
	DM5474	† National	
	DM7474	National	
	5474	† Raytheon	
	7474	Raytheon	
	7474	Signetics	
	5474	† Signetics	
	SW7474	SW	
	TL7474	Telefunken	
	SN5474	† TI	
	SN7474	TI	150
	TD3474	Toshiba	
	7474	TRW	
TTL-LS	9LS74C	Fairchild	
	9LS74M	† Fairchild	
	54LS74	† Fairchild	
	74LS74	Fairchild	
	DM54LS74	† National	
	DM74LS74	National	
	9LS74C	**Raytheon (235)**	
	9LS74M	**† Raytheon (235)**	160
	54LS74	**† Raytheon (235)**	
	74LS74	**Raytheon (235)**	
	74LS74	Signetics	
	54LS74	† Signetics	
	SN54LS74	† TI	
	SN74LS74	TI	
TTL-H	54H74	† Fairchild	
	74H74	Fairchild	
	ITT54H74	† ITT	
	ITT74H74	ITT	170
	MC3060	Motorola	
	MC3160	† Motorola	
	DM54H74	† National	
	DM74H74	National	
	54H74	† Raytheon	
	54R74	† Raytheon	
	74H74	Raytheon	
	74R74	Raytheon	
	54H74	† Signetics	
	74H74	Signetics	180
	SN54H74	† TI	
	SN74H74	TI	
TTL-S	54S74	† Fairchild	
	74S74	Fairchild	
	HD74S74	Hitachi	
	DM74S74	National	
	74S74	Signetics	
	SN54S74	† TI	
	SN74S74	TI	
Dual Gated D Flip-Flop			190
TTL	DM7511	† National	
	DM8511	National	

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Function	Device	Source	Line
Flip-Flops (Cont'd)			
Quad Gated D Flip-Flop			
TTL	DM7613	† National	
	DM8613	National	
Quad D-Type Flip-Flop, Common Clock			
TTL	MC4015	Motorola	
Quad D-Type Flip-Flop, Three-State			
TTL	DM54173	† National	
	DM74173	National	
	DM7551	† National	10
	DM8551	National	
	RC8T10	Raytheon	
	RM8T10	† Raytheon	
	N8T10	Signetics	
	S8T10	† Signetics	
	TL74173	Telefunken	
	SN54173	† TI	
	SN74173	TI	
TTL-LS	DM54LS173	† National	
	DM74LS173	National	20
Quad D-Type Edge-Triggered Flip-Flop with Clear, Complementary Output			
TTL	SN54175	† AMD	
	SN74175	AMD	
	54175	† Fairchild	
	74175	Fairchild	
	ZN54175	† Ferranti	
	ZN74175	Ferranti	
	HD74175	Hitachi	
	DM54175	† National	30
	DM74175	National	
	54175	† Raytheon	
	74175	Raytheon	
	74175	Signetics	
	54175	† Signetics	
	SW74175	SW	
	TL74175	Telefunken	
	SN54175	† TI	
	SN74175	TI	
TTL-LS	AM25LS175C	AMD	40
	AM25LS175M	AMD	
	SN54LS175	† AMD	
	SN74LS175	AMD	
	9LS175C	Fairchild	
	9LS175M	† Fairchild	
	54LS175	† Fairchild	
	74LS175	Fairchild	
	DM54LS175	† National	
	DM74LS175	National	
	9LS175M	**† Raytheon (275)**	50
	9LS175C	**Raytheon (275)**	
	54LS175	**† Raytheon (275)**	
	74LS175	**Raytheon (275)**	
	25LS175C	**Raytheon (344)**	
	25LS175M	**† Raytheon (344)**	
	74LS175	Signetics	
	54LS175	† Signetics	
	SN54LS175	† TI	
	SN74LS175	TI	
TTL-S	SN54S175	† AMD	60
	SN74S175	AMD	
	54S175	† Fairchild	
	74S175	Fairchild	
	(Continued)		

Function	Device	Source	Line
Flip-Flops (Cont'd)			
Quad D-Type Edge-Triggered Flip-Flop with Clear, Complementary Output (Continued)			
	HD74S175	Hitachi	
	DM74S175	National	
	74S175	Signetics	70
	SN74S175	TI	
	SN54S175	† TI	
Quad D-Type Flip-Flop with Common Clock Enable			
TTL-LS	AM25LS08C	AMD	
	AM25LS08M	† AMD	
	SN54LS379	† AMD	
	SN74LS379	AMD	
	SN54LS379	† TI	
	SN74LS379	TI	80
TTL-S	AM25S08C	AMD	
	AM25S08M	† AMD	
Quad D-Type Flip-Flop, Standard TTL and Three-State Outputs			
TTL	AM2918C	AMD	
	AM2918M	† AMD	
	AM2918C	Raytheon	
	AM2918M	† Raytheon	
TTL-LS	AM25LS18C	AMD	
	AM25LS18M	† AMD	90
TTL-S	AM25S18C	AMD	
	AM25S18M	† AMD	
Octal D-Type Edge-Triggered Flip-Flop, Three-State			
TTL-LS	AM25LS374C	AMD	
	AM25LS374M	† AMD	
	SN54LS374	† AMD	
	SN74LS374	AMD	
	DM54LS374	† National	
	DM74LS374	National	100
	SN54LS364	† TI	
	SN74LS364	TI	
	SN54LS374	† TI	
	SN74LS374	TI	
TTL-S	SN74S374	TI	
Quad D-Type Flip-Flop with Multiplexed Dual Inputs			
TTL	54298	† Fairchild	
	74298	Fairchild	
	TL74298	Telefunken	110
	SN54298	† TI	
	SN74298	TI	
TTL-LS	AM25LS09C	AMD	
	AM25LS09M	† AMD	
	SN54LS399	† AMD	
	SN74LS399	AMD	
	9LS298C	Fairchild	
	9LS298M	† Fairchild	
	54LS298	† Fairchild	
	74LS298	Fairchild	120
	DM54LS298	† National	
	DM74LS298	National	
	9LS298C	**Raytheon (323)**	
	9LS298M	**† Raytheon (323)**	
	54LS298	**† Raytheon (323)**	
	74LS298	**Raytheon (323)**	
	SN54LS298	† TI	
	(Continued)		

Function	Device	Source	Line
Flip-Flops (Cont'd)			
Quad D-Type Flip-Flop with Multiplexed Dual Inputs (Continued)			130
	SN74LS298	TI	
	SN54LS398	† TI	
	SN74LS398	TI	
	SN54LS399	† TI	
	SN74LS399	TI	
TTL-S	AM25S09C	AMD	
	AM25S09M	† AMD	
Hex D-Type Flip-Flop with Common Enable			
TTL-LS	AM25LS07C	AMD	140
	AM25LS07M	† AMD	
	SN54LS378	† AMD	
	SN74LS378	AMD	
	SN54LS378	† TI	
	SN74LS378	TI	
TTL-S	AM25S07C	AMD	
	AM25S07M	† AMD	
Hex D-Type Edge-Triggered Flip-Flop with Clear			
TTL	SN54174	† AMD	150
	SN74174	AMD	
	54174	† Fairchild	
	74174	Fairchild	
	93174C	Fairchild	
	ZN54174	† Ferranti	
	ZN74174	Ferranti	
	HD74174	Hitachi	
	DM54174	† National	
	DM74174	National	
	54174	† Raytheon	160
	74174	Raytheon	
	74174	Signetics	
	54174	† Signetics	
	SW74174	SW	
	TL74174	Telefunken	
	SN54174	† TI	
	SN74174	TI	
TTL-LS	AM25LS174C	AMD	
	AM25LS174M	† AMD	
	SN54LS174	† AMD	170
	SN74LS174	AMD	
	9LS174C	Fairchild	
	9LS174M	† Fairchild	
	54LS174	† Fairchild	
	74LS174	Fairchild	
	DM54LS174	† National	
	DM74LS174	National	
	9LS174C	**Raytheon (275)**	
	9LS174M	**† Raytheon (275)**	
	54LS174	**† Raytheon (275)**	180
	74LS174	**Raytheon (275)**	
	25LS174C	**Raytheon (344)**	
	25LS174M	**† Raytheon (344)**	
	74LS174	Signetics	
	54LS174	† Signetics	
	SN54LS174	† TI	
	SN74LS174	TI	
TTL-S	SN54S174	† AMD	
	SN74S174	AMD	
	54S174	† Fairchild	190
	74S174	Fairchild	
	HD74S174	Hitachi	
	(Continued)		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL (Cont'd)

Function	Device	Source	Line
Flip-Flops (Cont'd)			
Hex D-Type Edge-Triggered Flip-Flop with Clear (Continued)			
	DM74S174	National	
	74S174	Signetics	
	SN54S174	† TI	
	SN74S174	TI	
Octal D-Type, Edge-Triggered Flip-Flop, with Clear			
TTL	SN74273	TI	10
TTL-LS	AM25LS273C	AMD	
	AM25LS273M	† AMD	
	SN54LS273	† AMD	
	SN74LS273	AMD	
	SN54LS273	† TI	
	SN74LS273	TI	
Octal D-Type Flip-Flop with Enable			
TTL-LS	AM25LS377C	AMD	
	AM25LS377M	† AMD	
	SN54LS377	† TI	20
	SN74LS377	TI	
Quad I/O Register, Three-State (two terminals per flip-flop can be used as input or output)			
TTL	DM7542	† National	
	DM8542	National	
Octal Storage Register			
TTL-LS	SN54LS396	† TI	
	SN74LS396	TI	
Gates, AND/NAND			30
Dual 4-Input AND Gate			
TTL	5421	† Fairchild	
	7421	Fairchild	
	ITT5421	† ITT	
	ITT7421	ITT	
	5421	† Raytheon	
	7421	Raytheon	
	7421	Signetics	
	5421	† Signetics	
	TD3421	Toshiba	40
TTL-LS	9LS21C	Fairchild	
	9LS21M	† Fairchild	
	54LS21	† Fairchild	
	74LS21	Fairchild	
	DM54LS21	† National	
	DM74LS21	National	
	9LS21C	Raytheon	
	54LS21	**† Raytheon (215)**	
	9LS21M	**† Raytheon (215)**	
	74LS21	**Raytheon (215)**	50
	54LS21	† Signetics	
	74LS21	Signetics	
	SN74LS21	TI	
	SN54LS21	† TI	
TTL-H	54H21	† Fairchild	
	74H21	Fairchild	
	ITT54H21	† ITT	
	ITT74H21	ITT	
	MC3011	Motorola	
	MC3111	† Motorola	60
	DM54H21	† National	
	DM74H21	National	
	(Continued)		

Function	Device	Source	Line
Gates, AND/NAND (Cont'd)			
Dual 4-Input AND Gate (Continued)			
	54H21	† Signetics	
	74H21	Signetics	
	SN74H21	† TI	
	SN74H21	TI	
Dual 4-Input AND Power Gate			70
TTL-H	MC3026	Motorola	
	MC3126	† Motorola	
Triple 3-Input AND Gate			
TTL	5411	† Fairchild	
	7411	Fairchild	
	ITT5411	† ITT	
	ITT7411	ITT	
	DM5411	† National	
	DM7411	National	
	5411	† Raytheon	80
	7411	Raytheon	
	7411	Signetics	
	5411	† Signetics	
TTL-LS	9LS11C	Fairchild	
	9LS11M	† Fairchild	
	54LS11	† Fairchild	
	74LS11	Fairchild	
	DM54LS11	† National	
	DM74LS11	National	
	9LS11C	**Raytheon (215)**	90
	54LS11	**† Raytheon (215)**	
	9LS11M	**† Raytheon (215)**	
	74LS11	**Raytheon (215)**	
	74LS11	Signetics	
	54LS11	† Signetics	
	SN54LS11	TI	
	SN74LS11	† TI	
TTL-H	54H11	† Fairchild	
	74H11	Fairchild	
	ITT54H11	† ITT	100
	ITT74H11	ITT	
	MC3006	Motorola	
	MC3106	† Motorola	
	DM54H11	† National	
	DM74H11	National	
	54H11	† Raytheon	
	54R11	† Raytheon	
	74H11	Raytheon	
	74R11	Raytheon	
	54H11	† Signetics	110
	74H11	Signetics	
	SN54H11	† TI	
	SN74H11	TI	
TTL-S	54S11	† Fairchild	
	74S11	Fairchild	
	HD74S11	Hitachi	
	DM74S11	National	
	74S11	Signetics	
	54S11	† Signetics	
	SN54S11	† TI	120
	SN74S11	TI	
Triple 3-Input AND Gate, Open Collector			
TTL	5415	† Raytheon	
	7415	Raytheon	
TTL-LS	9LS15C	Fairchild	
	9LS15M	† Fairchild	
	(Continued)		

Function	Device	Source	Line
Gates, AND/NAND (Cont'd)			
Triple 3-Input AND Gate, Open Collector (Continued)			130
	54LS15	† Fairchild	
	74LS15	Fairchild	
	DM54LS15	† National	
	DM74LS15	National	
	9LS15C	**Raytheon (217)**	
	9LS15M	**† Raytheon (217)**	
	54LS15	**† Raytheon (217)**	
	74LS15	**Raytheon (217)**	
	74LS15	Signetics	
	54LS15	† Signetics	140
	SN54LS15	† TI	
	SN74LS15	TI	
TTL-H	54H15	† Fairchild	
	74H15	Fairchild	
	54H15	† Raytheon	
	54R15	† Raytheon	
	74H15	Raytheon	
	74R15	Raytheon	
	TL74H15	Telefunken	
	SN54H15	† TI	150
	SN74H15	TI	
TTL-S	54S15	† Fairchild	
	74S15	Fairchild	
	HD74S15	Hitachi	
	DM74S15	National	
	74S15	Signetics	
	54S15	† Signetics	
	SN54S15	† TI	
	SN74S15	TI	
Quad 2-Input AND Gate			160
TTL	5408	† Fairchild	
	7408	Fairchild	
	ZN5408	† Ferranti	
	ZN7408	Ferranti	
	HD2550	Hitachi	
	ITT5408	† ITT	
	ITT7408	ITT	
	MC5408	† Motorola	
	MC7408	Motorola	
	DM5408	† National	170
	DM7408	National	
	5408	† Raytheon	
	7408	Raytheon	
	7408	Signetics	
	5408	† Signetics	
	SW7408	SW	
	TL7408	Telefunken	
	SN5408	† TI	
	SN7408	TI	
	TD3408	Toshiba	180
	7408	TRW	
TTL-LS	9LS08C	Fairchild	
	9LS08M	† Fairchild	
	54LS08	† Fairchild	
	74LS08	Fairchild	
	DM54LS08	† National	
	DM74LS08	National	
	9LS08C	**Raytheon (215)**	
	9LS08M	**† Raytheon (215)**	
	54LS08	**† Raytheon (215)**	190
	74LS08	**Raytheon (215)**	
	(Continued)		

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Function	Device	Source	Line
Gates, AND/NAND (Cont'd)			
Quad 2-Input AND Gate (Continued)			
	74LS08	Signetics	
	54LS08	† Signetics	
	SN54LS08	† TI	
	SN74LS08	TI	
TTL-H	54H08	† Fairchild	
	74H08	Fairchild	
	MC3001	Motorola	
	MC3101	† Motorola	10
	DM54H08	† National	
	DM74H08	National	
	54H08	† Signetics	
	74H08	Signetics	
TTL-S	54S08	† Fairchild	
	74S08	Fairchild	
	74S08	Signetics	
	N54S08	† Signetics	
	SN54S08	† TI	
	SN74S08	TI	20
Quad 2-Input AND Gate, Open Collector			
TTL	5409	† Fairchild	
	7409	Fairchild	
	ZN5409	Ferranti	
	ZN7409	Ferranti	
	HD2551	Hitachi	
	ITT5409	† ITT	
	ITT7409	ITT	
	MC5409	† Motorola	
	MC7409	Motorola	30
	DM5409	† National	
	DM7409	National	
	5409	† Raytheon	
	7409	Raytheon	
	7409	Signetics	
	5409	† Signetics	
	SW7409	SW	
	TL7409	Telefunken	
	TL7409S1	Telefunken	
	SN5409	† TI	40
	SN7409	TI	
	TD3409	Toshiba	
	7409	TRW	
TTL-LS	9LS09C	Fairchild	
	9LS09M	† Fairchild	
	54LS09	† Fairchild	
	74LS09	Fairchild	
	DM54LS09	† National	
	DM74LS09	National	
	9LS09C	**Raytheon (217)**	50
	9LS09M	**† Raytheon (217)**	
	54LS09	**† Raytheon (217)**	
	74LS09	**Raytheon (217)**	
	74LS09	Signetics	
	54LS09	† Signetics	
	SN54LS09	† TI	
	SN74LS09	† TI	
TTL-H	54H09	† Fairchild	
	74H09	Fairchild	
TTL-S	54S09	† Fairchild	60
	74S09	Fairchild	
	74S09	Signetics	
	54S09	† Signetics	
	SN54S09	† TI	
	(Continued)		

Function	Device	Source	Line
Gates, AND/NAND (Cont'd)			
Quad 2-Input AND Gate, Open Collector (Continued)			
	SN74S09	TI	
2-2-3-3 Input AND Gate			70
TTL-S	9S41C	Fairchild	
	9S41M	† Fairchild	
8-Input NAND Gate			
TTL	5430	† Fairchild	
	7430	Fairchild	
	9007C	Fairchild	
	9007M	† Fairchild	
	ZN5430	† Ferranti	
	ZN7430	Ferranti	
	HD2508	Hitachi	80
	HD7430	Hitachi	
	ITT5430	† ITT	
	ITT7430	ITT	
	MC5430	† Motorola	
	MC7430	Motorola	
	DM5430	† National	
	DM7430	National	
	7430	Signetics	
	5430	† Signetics	
	SW7430	SW	90
	TL7430	Telefunken	
	SN5430	† TI	
	SN7430	TI	
	TD3430	Toshiba	
	7430	TRW	
	54H30	† Signetics	
	74H30	Signetics	
	SN54H30	† TI	
	SN74H30	TI	
TTL-LS	9LS30C	Fairchild	100
	9LS30M	† Fairchild	
	54LS30	† Fairchild	
	74LS30	Fairchild	
	DM54LS30	† National	
	DM74LS30	National	
	9LS30C	**Raytheon (210)**	
	9LS30M	**† Raytheon (210)**	
	54LS30	**† Raytheon (210)**	
	74LS30	**Raytheon (210)**	
	74LS30	Signetics	110
	54LS30	† Signetics	
	SN54LS30	† TI	
	SN74LS30	TI	
TTL-H	54H30	† Fairchild	
	74H30	Fairchild	
	ITT54H30	† ITT	
	ITT74H30	ITT	
	MC3015	Motorola	
	MC3016	Motorola	
	MC3115	† Motorola	120
	MC3116	† Motorola	
	DM54H30	† National	
	DM74H30	National	
TTL-S	54S30	† Fairchild	
	74S30	Fairchild	
	DM74S30	National	
	SN54S30	† TI	
	SN74S30	TI	

Function	Device	Source	Line
Gates, AND/NAND (Cont'd)			
12-Input NAND Gate, Three-State			130
TTL-S	54S134	† Fairchild	
	74S134	Fairchild	
	HD74S134	Hitachi	
	DM74S134	National	
	74S134	Signetics	
	SN54S134	† TI	
	SN74S134	TI	
13-Input NAND Gate			
TTL-LS	54LS133	† Fairchild	
	74LS133	Fairchild	140
TTL-S	54S133	† Fairchild	
	HD74S133	Hitachi	
	74S133	Fairchild	
	DM74S133	National	
	74S133	Signetics	
	SN54S133	† TI	
	SN74S133	TI	
Dual 4-Input NAND Gate			
TTL	5420	† Fairchild	
	7420	Fairchild	150
	9004C	Fairchild	
	9004M	† Fairchild	
	ZN7420	Ferranti	
	ZN5420	† Ferranti	
	HD2504	Hitachi	
	HD7420	Hitachi	
	ITT5420	† ITT	
	ITT7420	ITT	
	ITT9004-1	ITT	
	ITT9004-5	† ITT	160
	MC5420	† Motorola	
	MC7420	Motorola	
	DM5420	† National	
	DM7420	National	
	DM9004C	National	
	5420	† Raytheon	
	7420	Raytheon	
	7420	Signetics	
	5420	† Signetics	
	SW7420	SW	170
	TL7420	Telefunken	
	SN5420	† TI	
	SN7420	TI	
	TD3420	Toshiba	
	7420	TRW	
TTL-LS	9LS20C	Fairchild	
	9LS20M	† Fairchild	
	54LS20	† Fairchild	
	74LS20	Fairchild	
	DM54LS20	† National	180
	DM74LS20	National	
	9LS20C	**Raytheon (210)**	
	9LS20M	**† Raytheon (210)**	
	54LS20	**† Raytheon (210)**	
	74LS20	**Raytheon (210)**	
	74LS20	Signetics	
	54LS20	† Signetics	
	SN54LS20	† TI	
	SN74LS20	TI	
TTL-H	54H20	† Fairchild	190
	74H20	Fairchild	
	(Continued)		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL (Cont'd)

Gates, AND/NAND (Cont'd)

Function	Device	Source	Line
Dual 4-Input NAND Gate (Continued)			
	ITT54H20	† ITT	
	ITT74H20	ITT	
	MC3010	Motorola	
	MC3110	† Motorola	
	DM54H20	† National	
	DM74H20	National	
	54H20	† Raytheon	
	54R20	† Raytheon	10
	74H20	Raytheon	
	74R20	Raytheon	
	54H20	† Signetics	
	74H20	Signetics	
	SN54H20	† TI	
	SN74H20	TI	
TTL-S	54S20	† Fairchild	
	74S20	Fairchild	
	ZN54S20	† Ferranti	
	ZN74S20	Ferranti	20
	HD74S20	Hitachi	
	DM74S20	National	
	74S20	Signetics	
	SN54S20	† TI	
	SN74S20	TI	
Dual 4-Input NAND Buffer			
TTL	5440	† Fairchild	
	7440	Fairchild	
	9009C	Fairchild	
	9009M	† Fairchild	30
	ZN5440	† Ferranti	
	ZN7440	Ferranti	
	HD2501	Hitachi	
	HD7440	Hitachi	
	ITT5440	† ITT	
	ITT7440	ITT	
	ITT9009-1	† ITT	
	ITT9009-5	ITT	
	MC5440	† Motorola	
	MC7440	Motorola	40
	DM5440	† National	
	DM7440	National	
	DM9009C	National	
	7440	Signetics	
	5440	† Signetics	
	SW7440	SW	
	TL7440	Telefunken	
	SN5440	† TI	
	SN7440	TI	
	TD3440	Toshiba	50
	7440	TRW	
TTL-LS	9LS40C	Fairchild	
	9LS40M	† Fairchild	
	54LS40	† Fairchild	
	74LS40	Fairchild	
	DM54LS90	† National	
	DM74LS90	National	
	9LS40C	**Raytheon (223)**	
	9LS40M	**† Raytheon (223)**	
	54LS40	**† Raytheon (223)**	60
	74LS40	**Raytheon (223)**	
	74LS40	Signetics	
	54LS40	Signetics	
	SN54LS40	† TI	
	(Continued)		

Gates, AND/NAND (Cont'd)

Function	Device	Source	Line
Dual 4-Input NAND Buffer (Continued)			
	SN74LS40	TI	
TTL-H	54H40	† Fairchild	
	74H40	Fairchild	70
	ITT54H40	† ITT	
	ITT74H40	ITT	
	MC3024	Motorola	
	MC3025	Motorola	
	MC3124	† Motorola	
	MC3125	† Motorola	
	DM54H40	† National	
	DM74H40	National	
	54H40	† Raytheon	
	54H40	† Raytheon	80
	74H40	Raytheon	
	74R40	Raytheon	
	54H40	† Signetics	
	74H40	Signetics	
	SN54H40	† TI	
	SN74H40	TI	
TTL-S	54S40	† Fairchild	
	74S40	Fairchild	
	HD74S40	Hitachi	
	DM74S40	National	90
	74S40	Signetics	
	SN54S40	† TI	
	SN74S40	TI	
Dual 4-Input NAND Gate, Open Collector			
TTL	5422	† Fairchild	
	7422	Fairchild	
	HD7422	Hitachi	
	5422	† Raytheon	
	7422	Raytheon	
	TL7422	Telefunken	100
	SN5422	† TI	
	SN7422	TI	
TTL-LS	9LS22C	Fairchild	
	9LS22M	† Fairchild	
	54LS22	† Fairchild	
	74LS22	Fairchild	
	DM54LS22	† National	
	DM74LS22	National	
	9LS22C	**Raytheon (212)**	
	9LS22M	**† Raytheon (212)**	110
	54LS22	**† Raytheon (212)**	
	74LS22	**Raytheon (212)**	
	54LS22	† Signetics	
	74LS22	Signetics	
	SN54LS22	† TI	
	SN74LS22	TI	
TTL-H	54H22	† Fairchild	
	74H22	Fairchild	
	MC3012	Motorola	
	MC3112	† Motorola	120
	DM54H22	† National	
	DM74H22	National	
	54H22	† Raytheon	
	54R22	† Raytheon	
	74H22	Raytheon	
	74R22	Raytheon	
	54H22	† Signetics	
	74H22	Signetics	
	SN54H22	† TI	
	(Continued)		130

Gates, AND/NAND (Cont'd)

Function	Device	Source	Line
Dual 4-Input NAND Gate, Open Collector (Continued)			
	SN74H22	TI	
Dual 4-Input NAND Gate, Open Collector			
TTL-S	54S22	† Fairchild	
	74S22	Fairchild	
	ZN54S22	† Ferranti	
	ZN74S22	Ferranti	
	HD74S22	Hitachi	140
	DM74S22	National	
	74S22	Signetics	
	SN54S22	† TI	
	SN74S22	TI	
Dual 5-Input NAND Gate			
TTL	DM7092	† National	
	DM8092	National	
Triple 3-Input NAND Gate			
TTL	5410	† Fairchild	
	7410	Fairchild	150
	9003C	Fairchild	
	9003M	† Fairchild	
	ZN5410	† Ferranti	
	ZN7410	Ferranti	
	HD2507	Hitachi	
	HD7410	Hitachi	
	ITT5410	† ITT	
	ITT7410	ITT	
	ITT9003-1	† ITT	
	ITT9003-5	ITT	160
	MC5410	† Motorola	
	MC7410	Motorola	
	DM5410	† National	
	DM7410	National	
	DM9003C	National	
	5410	† Raytheon	
	7410	Raytheon	
	7410	Signetics	
	5410	† Signetics	
	SW7410	SW	170
	TL7410	Telefunken	
	SN5410	† TI	
	SN7410	TI	
	TD3410	Toshiba	
	7410	TRW	
TTL-LS	9LS10C	Fairchild	
	9LS10M	† Fairchild	
	54LS10	† Fairchild	
	74LS10	Fairchild	
	DM54LS10	† National	180
	DM74LS10	National	
	9LS10C	**Raytheon (210)**	
	9LS10M	**† Raytheon (210)**	
	54LS10	**† Raytheon (210)**	
	74LS10	**Raytheon (210)**	
	74LS10	Signetics	
	54LS10	† Signetics	
	SN54LS10	† TI	
	SN74LS10	TI	
TTL-H	54H10	† Fairchild	190
	74H10	Fairchild	
	ITT54H10	† ITT	
	ITT74H10	ITT	
	(Continued)		

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Gates, AND/NAND (Cont'd)

Triple 3-Input NAND Gate (Continued)

Function	Device	Source	Line
	MC3005	Motorola	
	MC3105	† Motorola	
	DM54H10	† National	
	DM74H10	National	
	54H10	† Raytheon	
	54R10	† Raytheon	
	74H10	Raytheon	
	74R10	Raytheon	10
	54H10	† Signetics	
	74H10	Signetics	
	SN54H10	† TI	
	SN74H10	TI	
TTL-S	54S10	† Fairchild	
	74S10	Fairchild	
	HD74S10	Hitachi	
	DM74S10	National	
	74S10	Signetics	
	SN54S10	† TI	20
	SN74S10	TI	

Triple 3-Input NAND Gate, Open Collector

Function	Device	Source	Line
TTL	5412	† Fairchild	
	7412	Fairchild	
	ZN5412	† Ferranti	
	ZN7412	Ferranti	
	HD7412	Hitachi	
	ITT5412	† ITT	
	ITT7412	ITT	
	5412	† Raytheon	30
	7412	Raytheon	
	7412	Signetics	
	5412	† Signetics	
	TL7412	Telefunken	
	SN5412	† TI	
	SN7412	TI	
	7412	TRW	
TTL-LS	DM54LS12	† National	
	DM74LS12	National	
	9LS12C	**Raytheon (212)**	40
	9LS12M	**† Raytheon (212)**	
	54LS12	**† Raytheon (212)**	
	74LS12	**Raytheon (212)**	
	74LS12	Signetics	
	54LS12	† Signetics	
	SN54LS12	† TI	
	SN74LS12	TI	
TTL-H	MC3007	Motorola	
	MC3107	† Motorola	

Quad 2-Input NAND Gate

Function	Device	Source	Line
TTL	5400	† Fairchild	50
	7400	Fairchild	
	9002C	Fairchild	
	9002M	† Fairchild	
	ZN5400	† Ferranti	
	ZN7400	Ferranti	
	HD2503	Hitachi	
	HD7400	Hitachi	
	ITT5400	† ITT	
	ITT7400	ITT	60
	ITT9002-1	† ITT	
	ITT9002-5	ITT	
	MC5400	† Motorola	

(Continued)

Gates, AND/NAND (Cont'd)

Quad 2-Input NAND Gate (Continued)

Function	Device	Source	Line
	MC7400	Motorola	
	DM5400	† National	
	DM7400	National	
	DM9002C	National	70
	5400	† Raytheon	
	7400	Raytheon	
	7400	Signetics	
	5400	† Signetics	
	SW7400	SW	
	TL7400	Telefunken	
	SN5400	† TI	
	SN7400	TI	
	TD3400	Toshiba	
	7400	TRW	80
TTL-LS	9LS00C	Fairchild	
	9LS00M	† Fairchild	
	54LS00	† Fairchild	
	74LS00	Fairchild	
	DM54LS00	† National	
	DM74LS00	National	
	9LS00C	**Raytheon (210)**	
	9LS00M	**† Raytheon (210)**	
	54LS00	**† Raytheon (210)**	
	74LS00	**Raytheon (210)**	90
	74LS00	Signetics	
	54LS00	† Signetics	
	SN54LS00	† TI	
	SN74LS00	TI	
TTL-H	54H00	† Fairchild	
	74H00	Fairchild	
	ITT54H00	† ITT	
	MC3000	Motorola	
	MC3100	† Motorola	
	DM54H00	† National	100
	DM74H00	National	
	54H00	† Raytheon	
	54R00	† Raytheon	
	74H00	Raytheon	
	74R00	Raytheon	
	54H00	† Signetics	
	74H00	Signetics	
	SN54H00	† TI	
	SN74H00	TI	
TTL-S	54S00	† Fairchild	110
	74S00	† Fairchild	
	ZN54S00	† Ferranti	
	ZN74S00	Ferranti	
	HD74S00	Hitachi	
	DM74S00	National	
	74S00	Signetics	
	SN54S00	† TI	
	SN74S00	TI	

Quad 2-Input NAND Buffer

Function	Device	Source	Line
TTL	5437	† Fairchild	120
	7437	Fairchild	
	ZN5437	† Ferranti	
	ZN7437	Ferranti	
	HD2552	Hitachi	
	ITT5437	† ITT	
	ITT7437	ITT	
	MC5437	† Motorola	
	MC7437	Motorola	

(Continued)

Gates, AND/NAND (Cont'd)

Quad 2-Input NAND Buffer (Continued)

Function	Device	Source	Line
	DM5437	† National	
	DM7091	† National	
	DM7437	National	
	DM8091	National	
	7437	Signetics	
	5437	† Signetics	
	SW7437	SW	
	TL7437	Telefunken	140
	SN5437	† TI	
	SN7437	TI	
	TD3437	Toshiba	
	7437	TRW	
TTL-LS	9LS37C	Fairchild	
	9LS37M	† Fairchild	
	54LS37	† Fairchild	
	74LS37	Fairchild	
	DM54LS37	† National	
	DM74LS37	National	150
	9LS37C	**Raytheon (223)**	
	9LS37C	**† Raytheon (223)**	
	54LS37	**† Raytheon (223)**	
	74LS37	**Raytheon (223)**	
	74LS37	Signetics	
	54LS37	† Signetics	
	SN54LS37	† TI	
	SN74LS37	TI	
TTL-S	SN54S37	† TI	
	SN74S37	TI	160
	74S37	Signetics	
	54S37	† Signetics	

Quad 2-Input NAND Gate, Open Collector

Function	Device	Source	Line
TTL	5401	† Fairchild	
	5403	† Fairchild	
	7401	Fairchild	
	7403	Fairchild	
	9012C	Fairchild	
	9012M	† Fairchild	
	ZN5401	† Ferranti	170
	ZN7401	Ferranti	
	HD2509	Hitachi	
	HD2528	Hitachi	
	HD7403	Hitachi	
	ITT5401	† ITT	
	ITT5403	† ITT	
	ITT7401	ITT	
	ITT7403	ITT	
	MC5401	† Motorola	
	MC5403	† Motorola	180
	MC7401	Motorola	
	MC7403	Motorola	
	DM5401	† National	
	DM5403	† National	
	DM7401	National	
	DM7403	National	
	DM9012C	National	
	5401	† Raytheon	
	7401	Raytheon	
	5403	† Raytheon	190
	7403	Raytheon	
	5401	† Signetics	
	5403	† Signetics	

(Continued)

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL (Cont'd)

Gates, AND/NAND (Cont'd)

Quad 2-Input NAND Gate, Open Collector (Continued)

Function	Device	Source	Line
	7401	Signetics	
	7403	Signetics	
	SW7401	SW	
	SW7403	SW	
	TL7401	Telefunken	
	TL7401S1	Telefunken	
	TL7401S3	Telefunken	10
	TL7403	Telefunken	
	TL7403S1	Telefunken	
	TL7403S2	Telefunken	
	SN5401	† TI	
	SN5403	† TI	
	SN7401	TI	
	SN7403	TI	
	TD3401	Toshiba	
	TD3403	Toshiba	
	7401	TRW	20
	7403	TRW	
TTL-LS	9LS03C	Fairchild	
	9LS03M	† Fairchild	
	54LS01	† Fairchild	
	74LS01	Fairchild	
	54LS03	† Fairchild	
	74LS03	Fairchild	
	DM54LS01	† National	
	DM74LS01	National	
	DM54LS03	† National	30
	DM74LS03	National	
	9LS01C	**Raytheon (212)**	
	9LS01M	**† Raytheon (212)**	
	54LS01	**† Raytheon (212)**	
	74LS01	**Raytheon (212)**	
	54LS03	**† Raytheon (212)**	
	9LS03C	**Raytheon (212)**	
	9LS03M	**† Raytheon (212)**	
	74LS03	**Raytheon (212)**	
	74LS01	Signetics	40
	74LS03	Signetics	
	74LS38	Signetics	
	54LS01	† Signetics	
	54LS03	† Signetics	
	54LS38	† Signetics	
	SN54LS01	† TI	
	SN74LS01	TI	
	SN54LS03	† TI	
	SN74LS03	TI	
TTL-H	54H01	† Fairchild	50
	74H01	Fairchild	
	ITT54H01	† ITT	
	ITT74H01	ITT	
	MC3004	Motorola	
	MC3104	† Motorola	
	DM54H01	† National	
	DM74H01	National	
	54H01	† Raytheon	
	74H01	Raytheon	
	54H03	† Raytheon	60
	74R03	Raytheon	
	54H01	† Signetics	
	74H01	Signetics	
	SN54H01	† TI	
	SN74H01	TI	

(Continued)

Gates, AND/NAND (Cont'd)

Quad 2-Input NAND Gate, Open Collector (Continued)

Function	Device	Source	Line
TTL-S	54S03	† Fairchild	70
	74S03	Fairchild	
	ZN54S03	† Ferranti	
	ZN74S03	Ferranti	
	HD74S03	Hitachi	
	DM74S03	National	
	74S03	Signetics	
	SN54S03	† TI	
	SN74S03	TI	

Quad 2-Input NAND Buffer, Open Collector

Function	Device	Source	Line
TTL	5438	† Fairchild	80
	7438	Fairchild	
	7439	Fairchild	
	ZN5438	† Ferranti	
	ZN7438	Ferranti	
	HD2544	Hitachi	
	ITT5438	† ITT	
	ITT7438	ITT	
	MC5438	† Motorola	
	MC7438	Motorola	
	DM5438	† National	90
	DM7438	National	
	7438	Signetics	
	7439	Signetics	
	5438	† Signetics	
	5439	† Signetics	
	SW7438	SW	
	TL7438	Telefunken	
	SN5438	† TI	
	SN7438	TI	
	TD3438	Toshiba	100
	7438	TRW	
TTL-LS	9LS38C	Fairchild	
	9LS38M	† Fairchild	
	54LS38	† Fairchild	
	74LS38	Fairchild	
	9LS38C	**Raytheon (226)**	
	9LS38M	**† Raytheon (226)**	
	54LS38	**† Raytheon (226)**	
	74LS38	**Raytheon (226)**	
	DM54LS38	† National	110
	DM74LS38	National	
	74LS38	Signetics	
	54LS38	† Signetics	
	SN54LS38	† TI	
	SN74LS38	TI	
TTL-S	SN54S38	† TI	
	SN74S38	TI	
	74S38	Signetics	
	54S38	† Signetics	

Quad 2-Input NAND Buffer, Open Collector, to 15v — 120

Function	Device	Source	Line
TTL-LS	54LS26	† Fairchild	
	74LS26	Fairchild	
	DM54LS26	† National	
	DM74LS26	National	
	54LS26	**† Raytheon (222)**	
	74LS26	**Raytheon (222)**	
	9LS26C	**Raytheon (222)**	
	9LS26M	**† Raytheon (222)**	
	74LS26	Signetics	130

(Continued)

Gates, AND/NAND (Cont'd)

Quad 2-Input NAND Buffer, Open Collector, to 15v (Continued)

Function	Device	Source	Line
	54LS26	† Signetics	
	SN54LS26	† TI	
	SN74LS26	TI	

Quad 2-Input NAND Buffer, Three-State

Function	Device	Source	Line
TTL	DM7099	† National	
	DM8099	National	140

Gates, AND-OR/AND-OR-Invert

Dual 2-4 Input AND/OR Gate

Function	Device	Source	Line
TTL-S	9S42C	Fairchild	
	9S42M	Fairchild	

2-2-2-3-Input AND-OR Gate, Expandable

Function	Device	Source	Line
TTL-H	54H52	† Fairchild	
	74H52	Fairchild	
	MC3031	Motorola	
	MC3131	† Motorola	
	DM54H52	† National	150
	DM74H52	National	
	54H52	† Signetics	
	74H52	Signetics	
	SN54H52	† TI	
	SN74H52	TI	

2-2-2-3-Input AND-OR-Invert Gate, Expandable

Function	Device	Source	Line
TTL	9008C	Fairchild	
	9008M	† Fairchild	
	ITT9008-1	† ITT	160
	ITT9008-5	ITT	
	DM9008C	National	

4-Wide 2-Input AND-OR-Invert Gate

Function	Device	Source	Line
TTL	5454	† Fairchild	
	7454	Fairchild	
	ZN5454	† Ferranti	
	ZN7454	Ferranti	
	HD2514	Hitachi	
	HD7454	Hitachi	
	ITT5454	† ITT	170
	ITT7454	ITT	
	MC5454	† Motorola	
	MC7454	Motorola	
	DM5454	† National	
	DM7454	National	
	7454	Signetics	
	5454	† Signetics	
	SW7454	SW	
	TL7454	Telefunken	
	SN5454	† TI	180
	SN7454	TI	
	7454	TRW	

4-Wide 2-2-3-3-Input AND-OR-Invert Gate

Function	Device	Source	Line
TTL-LS	9LS54C	Fairchild	
	9LS54M	† Fairchild	
	54LS54	† Fairchild	
	74LS54	Fairchild	
	DM54LS54	† National	
	DM74LS54	National	
	TL7454	Telefunken	190
	54LS54	**† Raytheon (230)**	
	9LS54C	Raytheon	

(Continued)

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Gates, AND-OR/AND-OR-Invert (Cont'd)

Function	Device	Source	Line
4-Wide 2-2-3-3-Input AND-OR-Invert Gate (Continued)			
	9LS54M	**† Raytheon (230)**	
	74LS54	**Raytheon (230)**	
	74LS54	Signetics	
	54LS54	† Signetics	
	SN54LS54	† TI	
	SN74LS54	TI	10
2-2-2-3-Input AND-OR-Invert Gate			
TTL-H	54H54	† Fairchild	
	74H54	Fairchild	
	ITT54H54	† ITT	
	ITT74H54	ITT	
	MC3033	Motorola	
	MC3133	† Motorola	
	DM54H54	† National	
	DM74H54	National	
	54H54	† Signetics	20
	74H54	Signetics	
	SN54H54	† TI	
	SN74H54	TI	
4-Wide 2-Input AND-OR-Invert Gate, Expandable			
TTL	5453	† Fairchild	
	7453	Fairchild	
	ZN5453	† Ferranti	
	ZN7453	Ferranti	
	HD2512	Hitachi	30
	HD2578	Hitachi	
	HD7453	Hitachi	
	ITT5453	† ITT	
	ITT7453	ITT	
	MC5453	† Motorola	
	MC7453	Motorola	
	DM5453	† National	
	DM7453	National	
	7453	Signetics	
	5453	† Signetics	40
	SW7453	SW	
	TL7453	Telefunken	
	SN5453	† TI	
	SN7453	TI	
	7453	TRW	
2-2-2-3-Input AND-OR-Invert Gate, Expandable			
TTL-H	54H53	† Fairchild	
	74H53	Fairchild	
	ITT54H53	† ITT	50
	ITT74H53	ITT	
	MC3032	Motorola	
	MC3132	† Motorola	
	DM54H53	† National	
	DM74H53	National	
	54H53	† Signetics	
	74H53	Signetics	
	SN54H53	† TI	
	SN74H53	TI	
4-2-3-2-Input AND-OR-Invert Gate			60
TTL-H	54R64	† Raytheon	
	74R64	Raytheon	
TTL-S	54S64	† Fairchild	
	74S64	† Fairchild	
	(Continued)		

Gates, AND-OR/AND-OR-Invert (Cont'd)

Function	Device	Source	Line
4-2-3-2-Input AND-OR-Invert Gate (Continued)			
	HD74S64	Hitachi	70
	DM74S64	National	
	74S64	† Signetics	
	SN54S64	TI	
	SN74S64	TI	
4-2-3-2-Input AND-OR-Invert Gate, Open Collector			
TTL-H	54R65	† Raytheon	
	74R65	Raytheon	
TTL-S	54S65	† Fairchild	80
	74S65	† Fairchild	
	HD74S65	Hitachi	
	DM74S65	National	
	74S65	Signetics	
	SN54S65	† TI	
	SN74S65	TI	
Dual 2-Wide 2-Input AND-OR-Invert Gate			
TTL	5451	† Fairchild	
	7451	Fairchild	
	ZN7451	Ferranti	90
	ZN5451	† Ferranti	
	HD2505	Hitachi	
	HD7451	Hitachi	
	ITT5451	† ITT	
	ITT7451	ITT	
	MC5451	† Motorola	
	MC7451	Motorola	
	DM5451	† National	
	DM7451	National	
	7451	Signetics	100
	5451	† Signetics	
	SW7451	SW	
	TL7451	Telefunken	
	SN5451	† TI	
	SN7451	TI	
	TD3451	Toshiba	
	7451	TRW	
Dual 2-Wide 2-Input AND-OR Invert Gate			
TTL-H	54H51	† Fairchild	
	74H51	Fairchild	110
	ITT54H51	† ITT	
	ITT74H51	ITT	
	MC3023	Motorola	
	MC3123	† Motorola	
	DM54H51	† National	
	DM74H51	National	
	54H51	† Signetics	
	74H51	Signetics	
	SN54H51	† TI	
	SN74H51	TI	120
TTL-S	54S51	† Fairchild	
	74S51	Fairchild	
	DM74S51	National	
	74S51	Signetics	
	SN54S51	† TI	
	SN74S51	TI	

Gates, AND-OR-Invert (Cont'd)

Function	Device	Source	Line
Dual 2-Wide 2/3-Input AND-OR-Invert Gate			
TTL-LS	9LS51C	Fairchild	
	9LS51M	† Fairchild	130
	54LS51	† Fairchild	
	74LS51	Fairchild	
	DM54LS51	† National	
	DM74LS51	National	
	9LS51C	**Raytheon (230)**	
	9LS51M	**† Raytheon (230)**	
	54LS51	**† Raytheon (230)**	
	74LS51	**Raytheon (230)**	
	74LS51	Signetics	
	54LS51	† Signetics	140
	SN54LS51	† TI	
	SN74LS51	TI	
2-Wide, 4-Input AND-OR-Invert Gate			
TTL-LS	9LS55C	Fairchild	
	9LS55M	† Fairchild	
	54LS55	† Fairchild	
	74LS55	Fairchild	
	DM54LS55	† National	
	DM74LS55	National	
	9LS55C	**Raytheon (230)**	150
	9LS55M	**† Raytheon (230)**	
	54LS55	**† Raytheon (230)**	
	74LS55	**Raytheon (230)**	
	74LS55	Signetics	
	54LS55	† Signetics	
	SN54LS55	† TI	
	SN74LS55	TI	
2-Wide, 4-Input AND-OR-Invert Gate, Expandable			
TTL-H	54H55	† Fairchild	160
	74H55	Fairchild	
	MC3034	Motorola	
	MC3134	† Motorola	
	DM54H55	† National	
	DM74H55	National	
	54H55	† Signetics	
	74H55	Signetics	
	SN54H55	† TI	
	SN74H55	TI	
Dual 2-Wide 2-Input AND-OR-Invert Gate (one gate is expandable)			170
TTL	5450	† Fairchild	
	7450	Fairchild	
	5460	† Fairchild	
	7460	Fairchild	
	9005C	Fairchild	
	9005M	† Fairchild	
	ZN5450	† Ferranti	
	ZN7450	Ferranti	
	HD2506	Hitachi	180
	HD7450	Hitachi	
	ITT5450	† ITT	
	ITT7450	ITT	
	ITT9005-1	† ITT	
	ITT9005-5	ITT	
	MC5450	† Motorola	
	MC7450	Motorola	
	DM5450	† National	
	DM7450	National	
	DM9005C	National	190
	(Continued)		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL (Cont'd)

Gates, AND-OR-Invert (Cont'd)

Dual 2-Wide 2-Input AND-OR-Invert Gate (one gate is expandable) (Continued)

Function	Device	Source	Line
	7450	Signetics	
	5450	† Signetics	
	SW7450	SW	
	TL7450	Telefunken	
	SN5450	† TI	
	SN7450	TI	
	TD3450	Toshiba	10
	7450	TRW	
TTL-H	54H50	† Fairchild	
	74H50	Fairchild	
	ITT54H50	† ITT	
	ITT74H50	ITT	
	MC3020	Motorola	
	MC3120	† Motorola	
	DM54H50	† National	
	DM74H50	National	
	54H50	† Signetics	20
	74H50	Signetics	
	SN54H50	† TI	
	SN74H50	TI	

Dual 4-Input Expander (for 54/7423, 54/7450, 54/7453)

Function	Device	Source	Line
TTL	5460	† Fairchild	
	7460	Fairchild	
	ZN5460	† Ferranti	
	ZN7460	Ferranti	
	HD2502	Hitachi	30
	HD7460	Hitachi	
	ITT5460	† ITT	
	ITT7460	ITT	
	MC5460	† Motorola	
	MC7460	Motorola	
	DM5460	† National	
	DM7460	National	
	7460	Signetics	
	5460	† Signetics	
	SW7460	SW	40
	TL7460	Telefunken	
	SN5460	† TI	
	SN7460	TI	
	TD3460	Toshiba	
	7460	TRW	

Dual 4-Input Extender (for 9005, 9008)

Function	Device	Source	Line
TTL	9006C	Fairchild	
	9006M	† Fairchild	
	DM9006C	National	

Gates, Exclusive OR/NOR

			50

Quad 2-Input Exclusive-OR Gate

Function	Device	Source	Line
TTL	5486	† Fairchild	
	7486	Fairchild	
	ZN5486	† Ferranti	
	ZN7486	Ferranti	
	HD2526	Hitachi	
	HD7486	Hitachi	
	ITT5486	† ITT	
	ITT7486	ITT	
	MC5486	† Motorola	60
	MC7241	Motorola	
	MC7486	Motorola	
	MC8241	† Motorola	

(Continued)

Gates, Exclusive OR/NOR (Cont'd)

Quad 2-Input Exclusive-OR Gate (Continued)

Function	Device	Source	Line
	DM5486	National	
	DM7486	National	
	5486	† Raytheon	70
	7486	Raytheon	
	RC8241	Raytheon	
	RM8241	† Raytheon	
	7486	Signetics	
	N8241	Signetics	
	5486	† Signetics	
	S8241	† Signetics	
	SW7486	SW	
	TL7486	Telefunken	
	SN5486	† TI	80
	SN7486	TI	
	7486	TRW	
TTL-LS	9LS86C	Fairchild	
	9LS86M	† Fairchild	
	54LS86	† Fairchild	
	74LS86	Fairchild	
	9LS86C	**Raytheon (242)**	
	9LS86M	**† Raytheon (242)**	
	74LS86	**Raytheon (242)**	
	54LS86	**† Raytheon (242)**	90
	9LS386C	**Raytheon (242)**	
	9LS386M	**† Raytheon (242)**	
	54LS386	**† Raytheon (242)**	
	74LS386	**Raytheon (242)**	
	74LS86	Signetics	
	54LS86	† Signetics	
	74LS386	Signetics	
	54LS386	† Signetics	
	SN54LS86	† TI	
	SN74LS86	TI	100
	SN54LS386	† TI	
	SN74LS386	TI	
TTL-H	MC3021	Motorola	
	MC3121	† Motorola	
TTL-S	54S86	† Fairchild	
	74S86	Fairchild	
	HD74S86	Hitachi	
	DM74S86	National	
	N82S41	Signetics	
	74S86	Signetics	110
	54S86	† Signetics	
	SN54S86	† TI	
	SN74S86	TI	

Quad 2-Input Exclusive OR Gate (two of the outputs are complemented)

Function	Device	Source	Line
TTL	9014C	Fairchild	
	9014M	† Fairchild	

Quad 2-Input Exclusive-OR Gate, Open Collector

Function	Device	Source	Line
TTL	HD74136	Hitachi	120
	54136	† Raytheon	
	74136	Raytheon	
	TL74136	Telefunken	
	SN54136	† TI	
	SN74136	TI	
	74136	TRW	
TTL-LS	9LS136C	Fairchild	
	9LS136M	† Fairchild	

(Continued)

Gates, Exclusive OR/NOR (Cont'd)

Quad 2-Input Exclusive-OR Gate, Open Collector (Continued)

Function	Device	Source	Line
	54LS136	Fairchild	
	74LS136	Fairchild	
	9LS136C	**Raytheon (253)**	
	9LS136M	**† Raytheon (253)**	
	54LS136	**† Raytheon (253)**	
	74LS136	**Raytheon (253)**	
	74LS136	Signetics	140
	54LS136	† Signetics	
	SN54LS136	† TI	
	SN74LS136	TI	
TTL-S	DM74S136	National	

Quad 2-Input Exclusive NOR Gate

Function	Device	Source	Line
TTL-H	MC3022	Motorola	
	MC3122	† Motorola	

Quad 2-Input Exclusive NOR Gate, Open Collector

Function	Device	Source	Line
TTL	9386C	Fairchild	150
	9386M	† Fairchild	
	MC7242	Motorola	
	MC8242	† Motorola	
	RC8242	Raytheon	
	RM8242	† Raytheon	
	N8242	Signetics	
	S8242	† Signetics	
TTL-LS	9LS266C	Fairchild	
	9LS266M	† Fairchild	
	54LS266	† Fairchild	160
	74LS266	Fairchild	
	9LS266C	**Raytheon (253)**	
	9LS266M	**† Raytheon (253)**	
	54LS266	**† Raytheon (253)**	
	74LS266	**Raytheon (253)**	
	74LS266	Signetics	
	54LS266	† Signetics	
	SN54LS266	† TI	
	SN74LS266	TI	
TTL-H	N82S42	Signetics	170

Quad 2-Input OR/NOR Gate

Function	Device	Source	Line
TTL-S	54S135	† Fairchild	
	74S135	Fairchild	
	HD74S135	Hitachi	
	DM74S135	National	
	74S135	Signetics	
	SN54S135	† TI	
	SN74S135	TI	

Gates, OR/NOR

Quad 2-Input OR Gate

Function	Device	Source	Line
TTL	5432	† Fairchild	180
	7432	Fairchild	
	ZN5432	† Ferranti	
	ZN7432	Ferranti	
	HD7432	Hitachi	
	ITT5432	† ITT	
	ITT7432	ITT	
	DM5432	† National	
	DM7432	National	
	7432	Signetics	190
	5432	† Signetics	

(Continued)

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Gates, OR/NOR (Cont'd)

Function	Device	Source	Line
Quad 2-Input OR Gate (Continued)			
	TL7432	Telefunken	
	SW7432	SW	
	SN5432	† TI	
	SN7432	TI	
TTL-LS	9LS32C	Fairchild	
	9LS32M	† Fairchild	
	54LS32	† Fairchild	
	74LS32	Fairchild	10
	DM54LS32	† National	
	DM74LS32	National	
	9LS32C	**Raytheon (225)**	
	9LS32M	**† Raytheon (225)**	
	54LS32	**† Raytheon (225)**	
	74LS32	**Raytheon (225)**	
	74LS32	Signetics	
	54LS32	† Signetics	
	SN54LS32	† TI	
	SN74LS32	TI	20
TTL-S	54S32	† Fairchild	
	74S32	Fairchild	
	SN54S32	† TI	
	SN74S32	TI	
2-2-2-4 Input NOR Gate			
TTL	9015C	Fairchild	
	9015M	† Fairchild	
Dual 4-Input NOR Gate, with Strobe			
TTL	5425	† Fairchild	
	7425	Fairchild	30
	ZN5425	† Ferranti	
	ZN7425	Ferranti	
	ITT5425	† ITT	
	ITT7425	ITT	
	DM5425	† National	
	DM7425	National	
	SW7425	SW	
	TL7425	Telefunken	
	SN5425	† TI	
	SN7425	TI	40
Dual 4-Input NOR Gate, with Strobe, Expandable (see 54/7460 Expander)			
TTL	5423	† Fairchild	
	7423	Fairchild	
	DM5423	† National	
	DM7423	National	
	SW7423	SW	
	TL7423	Telefunken	
	SN5423	† TI	
	SN7423	TI	50
Dual 5-Input NOR Gate			
TTL-LS	54LS260	† Fairchild	
	74LS260	Fairchild	
	74LS260A	Signetics	
	54LS260A	† Signetics	
	DM74S260	National	
	74S260	Signetics	
	54S260	† Signetics	
Dual 5-Input NOR Gate			
TTL-S	SN54S260	† TI	60
	SN74S260	TI	

Gates, OR/NOR (Cont'd)

Function	Device	Source	Line
Triple 3-Input NOR Gate			
TTL	5427	† Fairchild	
	7427	Fairchild	
	ZN5427	† Ferranti	
	ZN7427	Ferranti	
	HD7427	Hitachi	
	DM5427	† National	
	DM7427	National	70
	7427	Signetics	
	SW7427	SW	
	TL7427	Telefunken	
	SN5427	† TI	
	SN7427	TI	
TTL-LS	9LS27C	Fairchild	
	9LS27M	† Fairchild	
	54LS27	† Fairchild	
	74LS27	Fairchild	
	DM54LS27	† National	80
	DM74LS27	National	
	9LS27C	**Raytheon (214)**	
	9LS27M	**† Raytheon (214)**	
	54LS27	**† Raytheon (214)**	
	74LS27	**Raytheon (214)**	
	74LS27	Signetics	
	54LS27	† Signetics	
	SN54LS27	† TI	
	SN74LS27	TI	
Quad 2-Input NOR Gate (54/7428 devices are also buffers)			90
TTL	5402	† Fairchild	
	7402	Fairchild	
	ZN5428	† Ferranti	
	ZN7428	Ferranti	
	HD2511	Hitachi	
	HD7402	Hitachi	
	ITT5402	† ITT	
	ITT7402	ITT	
	ITT5428	† ITT	100
	ITT7428	ITT	
	MC5402	† Motorola	
	MC7402	Motorola	
	DM5402	† National	
	DM7402	National	
	7402	Signetics	
	5402	† Signetics	
	7428	Signetics	
	SW7402	SW	
	TL7402	Telefunken	110
	TL7428	Telefunken	
	SN5402	† TI	
	SN5428	† TI	
	SN7402	TI	
	SN7428	TI	
	7402	TRW	
TTL-LS	9LS02C	Fairchild	
	9LS02M	† Fairchild	
	54LS02	† Fairchild	
	74LS02	Fairchild	120
	DM54LS02	† National	
	DM74LS02	National	
	9LS02C	Raytheon	
	9LS02M	**† Raytheon (214)**	
	54LS02	**† Raytheon (214)**	

(Continued)

Gates, OR/NOR (Cont'd)

Function	Device	Source	Line
Quad 2-Input NOR Gate (54/7428 devices are also buffers) (Continued)			
	74LS02	**Raytheon (214)**	130
	9LS28C	**Raytheon (223)**	
	9LS28M	**† Raytheon (223)**	
	54LS28	**† Raytheon (223)**	
	74LS28	**Raytheon (223)**	
	74LS02	Signetics	
	S54LS02	† Signetics	
	74LS28	Signetics	
	S54LS28	† Signetics	
	SN54LS02	† TI	
	SN74LS02	TI	140
	SN54LS28	† TI	
	SN74LS28	TI	
TTL-S	54S02	† Fairchild	
	74S02	Fairchild	
	DM74S02	National	
	74S02	Signetics	
	54S02	† Signetics	
	SN54S02	† TI	
	SN74S02	TI	
Quad 2-Input NOR Buffer, Open Collector			150
TTL	ITT5433	† ITT	
	ITT7433	ITT	
	7433	Signetics	
	TL7433	Telefunken	
	SN5433	† TI	
	SN7433	TI	
	54LS33	† Fairchild	
	74LS33	Fairchild	
TTL-LS	**54LS33**	**† Raytheon (226)**	
	9LS33C	**Raytheon (226)**	160
	9LS33M	**† Raytheon (226)**	
	74LS33	**Raytheon (226)**	
	74LS33	Signetics	
	54LS33	† Signetics	
	SN54LS33	† TI	
	SN74LS33	TI	
Quad 2-Input OR Gate			
TTL-H	MC3003	Motorola	
	MC3103	† Motorola	
Quad 2-Input NOR Gate			170
TTL-H	MC3002	Motorola	
	MC3102	† Motorola	
	54R02	† Raytheon	
	74R02	Raytheon	

Gates Miscellaneous

Function	Device	Source	Line
Quad Inverter and Dual 2-Input NAND Gate			
TTL	DM7090	† National	
	DM8090	National	
Dual Majority Logic Gate			
TTL	MC4062	Motorola	180

Latches

Function	Device	Source	Line
8-bit Addressable Latch, with Clear			
TTL	9334C	AMD	
	9334M	† AMD	
	SN54259	† AMD	
	SN74259	AMD	

(Continued)

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL (Cont'd)

Latches (Cont'd)

Function	Device	Source	Line
8-bit Addressable Latch, with Clear (Continued)			
	9334C	Fairchild	
	9334M	† Fairchild	
	DM8334	National	
	DM9334	† National	
	N9334	Signetics	
	SN54259	† TI	
	SN74259	TI	10
TTL-LS	54LS259	† Fairchild	
	74LS259	Fairchild	
	SN54LS259	† TI	
	SN74LS259	TI	
Dual 4-bit Addressable Latch			
TTL-LS	54LS255	† Fairchild	
	74LS255	Fairchild	
8-bit Latch, Three-State (input and output through the same pins)			
TTL	DM7553	† National	20
	DM8553	National	
8-bit Latch, Transparent, D Type, Three-State			
TTL-LS	SN54LS363	† TI	
	SN74LS363	TI	
	SN54LS373	† TI	
	SN74LS373	TI	
TTL-S	SN54S373	† TI	
	SN74S373	TI	
	SN54S412	† TI	30
	SN74S412	TI	
6-bit Latch (Independent 2 and 4-bit)			
TTL-S	3404	Intel	
Dual 4-bit Latch			
TTL	MC54100	† Motorola	
	MC74100	Motorola	
	74100	Signetics	
	54100	† Signetics	
	SW74100	SW	
	TL74100	Telefunken	40
	SN54100	† TI	
	SN74100	TI	
Dual 4-bit Latch with Clear			
TTL	9308C	AMD	
	9308M	† AMD	
	9308C	Fairchild	
	9308M	† Fairchild	
	54116	† Fairchild	
	74116	Fairchild	
	ITT9308-1	† ITT	50
	ITT9308-5	ITT	
	MC8308	Motorola	
	MC9308	† Motorola	
	RM9308	† Raytheon	
	RC9308	Raytheon	
	74116	Signetics	
	TL74116	Telefunken	
	SN29308	TI	
	SN39308	† TI	
	SN54116	† TI	60
	SN74116	TI	

Latches (Cont'd)

Function	Device	Source	Line
Quad Multifunction Latch			
TTL	9314C	AMD	
	9314M	† AMD	
	9314C	Fairchild	
	9314M	† Fairchild	
	MC8314	Motorola	
	MC9314	† Motorola	
Quad Bistable Latch, Single Output			70
TTL	5477	† Fairchild	
	7477	Fairchild	
	MC5477	† Motorola	
	MC7477	Motorola	
	7477	Signetics	
	5477	† Signetics	
	SN5477	† TI	
	SN7477	TI	
TTL-LS	54LS77	† Fairchild	
	74LS77	Fairchild	80
	DM74LS77	National	
	SN54LS77	† TI	
	SN74LS77	TI	
Quad Bistable Latch, Complementary Outputs			
TTL	5474	† Fairchild	
	7475	Fairchild	
	ZN5474	† Ferranti	
	ZN7475	Ferranti	
	HD2517	Hitachi	90
	HD7475	Hitachi	
	ITT5475	† ITT	
	ITT7475	ITT	
	MC5475	† Motorola	
	MC7475	Motorola	
	DM5475	† National	
	DM7475	National	
	7475	Signetics	
	5475	† Signetics	
	N8275	Signetics	100
	SW7475	SW	
	TL7475	Telefunken	
	SN5474	† TI	
	SN7475	TI	
	TD3475	Toshiba	
	7475	TRW	
TTL-LS	54LS75	† Fairchild	
	74LS75	Fairchild	
	DM54LS75	† National	
	DM74LS75	National	110
	74LS75	Signetics	
	54LS75	† Signetics	
	SN54LS75	† TI	
	SN74LS75	TI	
	SN54LS375	† TI	
	SN74LS375	TI	
Quad Set-Reset Latch			
TTL	54279	† Fairchild	
	74279	Fairchild	
	54279	† Signetics	120
	74279	Signetics	
	TL74279	Telefunken	
	SN54279	† TI	
	SN74279	TI	

(Continued)

Latches (Cont'd)

Function	Device	Source	Line
Quad Set-Reset Latch (Continued)			
TTL-LS	9LS279C	Fairchild	
	9LS279M	† Fairchild	
	54LS279	† Fairchild	130
	74LS279	Fairchild	
	DM54LS279	† National	
	DM74LS279	National	
	SN54LS279	† TI	
	SN74LS279	TI	
Hex Set-Reset Latch (Common Reset)			
TTL	ZN54118	† Ferranti	
	ZN54119	† Ferranti	
	ZN74118	Ferranti	
	ZN74119	Ferranti	140
	ITT54118	† ITT	
	ITT74118	ITT	
	TL74118	Telefunken	
	TL74119	Telefunken	

Memories

For additional information on these and larger TTL compatable memories, see the Master Selection Guide-Memory section

8-bit Multiport Register (RAM with simultaneous Read/Write)			150
TTL	9338C	AMD	
	9338M	† AMD	
	9338C	Fairchild	
	9338M	† Fairchild	
16-bit Active Element Memory			
TTL	93407C	Fairchild	
	93407M	† Fairchild	
	HM2501	Hitachi	
	MC4004	Motorola	
	MC4005	Motorola	160
	MC4304	† Motorola	
	MC4305	† Motorola	
	5481	† Raytheon	
	7481	Raytheon	
	TL7481	Telefunken	
	SN5481A	† TI	
	SN7481A	TI	
	7481	TRW	
16-bit Active Element Memory, Gated Write			
TTL	MC7484	Motorola	170
	TL7484	Telefunken	
	SN5484A	† TI	
	SN7484A	TI	
16-bit (4x4) Register File, Simultaneous Read/Write, Open Collector			
TTL	54170	† Fairchild	
	74170	Fairchild	
	ZN54170	† Ferranti	
	ZN74170	Ferranti	
	HD2540	Hitachi	180
	DM74170	National	
	54170	† Raytheon	
	74170	Raytheon	
	74170	Signetics	
	54170	† Signetics	
	TL74170	Telefunken	
	SN54170	† TI	

(Continued)

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Memories (Cont'd)

Function	Device	Source	Line
16-bit (4x4) Register File, Simultaneous Read/Write, Open Collector (Continued)			
	SN74170	TI	
TTL-LS	AM25LS170C	AMD	
	AM25LS170M	† AMD	
	SN54LS170	† AMD	
	SN74LS170	AMD	
	9LS170C	Fairchild	
	9LS170M	† Fairchild	10
	54LS170	† Fairchild	
	74LS170	Fairchild	
	DM54LS170	† National	
	DM74LS170	National	
	74LS170	Signetics	
	54LS170	† Signetics	
	SN54LS170	† TI	
	SN74LS170	TI	
16-bit (4x4) Register File, Simultaneous Read/Write, Three-State			20
TTL-LS	AM25LS670C	AMD	
	AM25LS670M	† AMD	
	SN54LS670	† AMD	
	SN74LS670	AMD	
	54LS670	† Fairchild	
	74LS670	Fairchild	
	54LS670	† Raytheon	
	DM54LS670	† National	
	DM74LS670	National	
	74LS670	Signetics	30
	54LS670	† Signetics	
	SN54LS670	† TI	
	SN74LS670	TI	
16-bit (8x2) Multiport Register File, Simultaneous Read/Write, Three-State			
TTL	74172	Signetics	
	TL74172	Telefunken	
	SN74172	TI	
TTL-S	74S172	Signetics	
16-bit (4x4) Content Addressable Memory			40
TTL	3104	Intel	
32-bit (8x4) Multiport RAM			
TTL-S	N82S12	Signetics	
	N82S112	Signetics	
64-Bit (16x4) Register File with Latch, Three-State			
TTL-S	**DM85S68**	**National (749)**	
64-Bit (32x2) Simultaneous Read/Write RAM			
TTL-S	DM86S21	National	
	N82S21	Signetics	50
64-Bit (16x4) Simultaneous Read/Write RAM with output register			
TTL	9410C	Fairchild	
	9410M	† Fairchild	
64-Bit (16x4) RAM with two output ports			
	AM29704C	AMD	
	AM29704M	† AMD	
	AM29705C	AMD	
	AM29705M	† AMD	
80-bit (16x5) First-In/First-Out Memory, Asynchronous, Three-State			60
TTL-S	SN74S225	TI	

Multiplexers

Function	Device	Source	Line
Quad 2-Input Multiplexer, Non-Inverting			
TTL	9322C	AMD	
	9322M	† AMD	
	SN54157	† AMD	
	SN74157	AMD	
	9322C	Fairchild	
	9322M	† Fairchild	70
	54157	† Fairchild	
	74157	Fairchild	
	ZN54157	† Ferranti	
	ZN74157	Ferranti	
	HD74157	Hitachi	
	ITT9322-1	ITT	
	ITT9322-5	ITT	
	ITT74157	ITT	
	ITT54157	† ITT	
	MC9322	† Motorola	80
	MC8322	Motorola	
	MC54157	† Motorola	
	MC74157	Motorola	
	DM8322	National	
	DM9322	† National	
	DM54157	† National	
	DM74157	National	
	RC8233	Raytheon	
	RM8233	† Raytheon	
	RC9322	Raytheon	90
	RM9322	† Raytheon	
	54157	† Raytheon	
	74157	Raytheon	
	N8233	Signetics	
	S8233	† Signetics	
	74157	Signetics	
	54157	† Signetics	
	SW74157	SW	
	TL74157	Telefunken	
	SN54157	† TI	100
	SN74157	TI	
TTL-LS	AM25LS157C	AMD	
	AM25LS157M	AMD	
	SN54LS157	† AMD	
	SN74LS157	AMD	
	9LS157C	Fairchild	
	9LS157M	† Fairchild	
	54LS157	† Fairchild	
	74LS157	Fairchild	
	9LS157C	**Raytheon (262)**	110
	9LS157M	**† Raytheon (262)**	
	54LS157	**† Raytheon (262)**	
	74LS157	**Raytheon (262)**	
	25LS157C	**Raytheon (338)**	
	25LS157M	**† Raytheon (338)**	
	DM54LS157	† National	
	DM74LS157	National	
	74LS157	Signetics	
	54LS157	Signetics	
	SN54LS157	† TI	120
	SN74LS157	TI	
TTL-S	SN54S157	† AMD	
	SN74S157	AMD	
	93S22C	AMD	
	93S22M	† AMD	
	54S157	† Fairchild	
	74S157	Fairchild	

(Continued)

Multiplexers (Cont'd)

Function	Device	Source	Line
Quad 2-Input Multiplexer, Non-Inverting (Continued)			130
	DM74S157	National	
	74S157	Signetics	
	N82S33	Signetics	
	SN54S157	† TI	
	SN74S157	TI	
Quad 2-Input Multiplexer, (Three-State 54/74157)			
TTL	DM7123	National	
	DM8123	† National	140
Quad 2-Input Multiplexer with Storage			
TTL	54298	† Fairchild	
	74298	Fairchild	
	74298	Signetics	
	54298	† Signetics	
	TL74298	Telefunken	
	SN54298	† TI	
	SN74298	TI	
Quad 2-Input Digital Multiplexer (Suitable for Driving Adders, Registers			150
TTL	MC7266	Motorola	
	MC8266	† Motorola	
	RC8266	Raytheon	
	RM8266	† Raytheon	
	N8266	Signetics	
	S8266	† Signetics	
TTL-S	N82S33	Signetics	
	N82S66	Signetics	
Quad 2-Input Multiplexer, Open Collector (for adder, register input)			160
TTL	MC7267	Motorola	
	MC8267	† Motorola	
	RC8267	Raytheon	
	RM8267	† Raytheon	
	N8267	Signetics	
	S8267	† Signetics	
TTL-S	N82S34	Signetics	
	N82S67	Signetics	
Quad 2-Input Multiplexer, Inverting			
TTL	54158	† Raytheon	170
	74158	Raytheon	
	74158	Signetics	
	54158	† Signetics	
TTL-LS	AM25LS158C	AMD	
	AM25LS158M	† AMD	
	SN54LS158	† AMD	
	SN74LS158	AMD	
	9LS158C	Fairchild	
	9LS158M	† Fairchild	
	54LS158	† Fairchild	180
	74LS158	Fairchild	
	DM54LS158	† National	
	DM74LS158	National	
	9LS158C	**Raytheon (262)**	
	9LS158M	**† Raytheon (262)**	
	74LS158	**Raytheon (262)**	
	25LS158C	**Raytheon (338)**	
	25LS158M	**† Raytheon (338)**	
	54LS158	**† Raytheon (262)**	
	74LS158	Signetics	190
	54LS158	† Signetics	

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† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL (Cont'd)

Multiplexers (Cont'd)

Function	Device	Source	Line
Quad 2-Input Multiplexer, Inverting (Continued)			
	SN54LS158	† TI	
	SN74LS158	TI	
TTL-S	SN54S158	† AMD	
	SN74S158	AMD	
	54S158	† Fairchild	
	74S158	Fairchild	
	DM74S158	National	10
	74S158	Signetics	
	N82S66	Signetics	
	SN54S158	† TI	
	SN74S158	TI	
Quad 2-Input Multiplexer, Inverting Three-State			
TTL-LS	AM25LS258C	AMD	
	AM25LS258M	† AMD	
	SN54LS258	† AMD	
	SN74LS258	AMD	20
	9LS258C	Fairchild	
	9LS258M	† Fairchild	
	54LS258	† Fairchild	
	74LS258	Fairchild	
	9LS258C	**Raytheon (315)**	
	9LS258M	**† Raytheon (315)**	
	54LS258	**† Raytheon (315)**	
	74LS258	**Raytheon (315)**	
	25LS258C	**Raytheon (358)**	
	25LS258M	**† Raytheon (358)**	30
TTL-S	SN54S258	† AMD	
	SN74S258	AMD	
	54S258	† Fairchild	
	74S258	Fairchild	
Quad 2-Input Multiplexer, Non-Inverting, Three-State			
TTL-LS	AM25LS257C	AMD	
	AM25LS257M	† AMD	
	SN54LS257	† AMD	
	SN74LS257	AMD	40
	9LS257C	Fairchild	
	9LS257M	† Fairchild	
	54LS257	† Fairchild	
	74LS257	Fairchild	
	DM54LS257	† National	
	DM74LS257	National	
	9LS257C	**Raytheon (315)**	
	9LS257M	**† Raytheon (315)**	
	54LS257	**† Raytheon (315)**	
	74LS257	**Raytheon (315)**	50
	25LS257C	**Raytheon (358)**	
	25LS257M	**† Raytheon (358)**	
	74LS257	Signetics	
	54LS257	† Signetics	
	SN54LS257	† TI	
	SN74LS257	TI	
TTL-S	SN54S257	† AMD	
	SN74S257	AMD	
	54S257	† Fairchild	
	74S257	Fairchild	60
	DM74S257	National	
	54S257	† Signetics	
	74S257	Signetics	
	SN54S257	† TI	

(Continued)

Multiplexers (Cont'd)

Function	Device	Source	Line
Quad 2-Input Multiplexer, Non-Inverting, Three-State (Continued)			
	SN74S257	TI	
Quad 2-Input Multiplexer, Inverting, Open Collector			70
TTL	RC8234	Raytheon	
	RM8234	† Raytheon	
	N8234	Signetics	
	S8234	† Signetics	
Quad 2-Input Multiplexer, Conditional Complementing, Open Collector			
TTL	N8235	Signetics	
	S8235	† Signetics	
Quad 3-Input Multiplexer, Conditional Complementing			80
TTL	RC8263	Raytheon	
	RM8263	† Raytheon	
	N8263	Signetics	
	S8263	† Signetics	
Quad 3-Input Multiplexer, Open Collector, Conditional Complementing, Output Enable			
TTL	RC8264	Raytheon	
	RM8264	† Raytheon	
	N8264	Signetics	90
	S8264	Signetics	
Quad 2-Input Multiplexer with Storage			
TTL-LS	9LS298C	AMD	
	9LS298M	† AMD	
	AM25LS09C	AMD	
	AM25LS09M	† AMD	
	SN54LS399	† AMD	
	SN74LS399	AMD	
	9LS298C	Fairchild	
	9LS298M	† Fairchild	100
	54LS298	† Fairchild	
	74LS298	Fairchild	
	DM54LS298	† National	
	DM74LS298	National	
	SN54LS298	† TI	
	SN74LS298	TI	
	SN54LS398	† TI	
	SN74LS398	TI	
	SN54LS399	† TI	
	SN74LS399	TI	110
TTL-S	AM25S09C	AMD	
	AM25S09M	† AMD	
Dual 4-Input Multiplexer			
TTL	54153	† Fairchild	
	74153	Fairchild	
	ZN54153	† Ferranti	
	ZN74153	Ferranti	
	HD2564	Hitachi	
	ITT54153	† ITT	
	ITT74153	ITT	120
	MC4000	Motorola	
	MC4300	† Motorola	
	MC54153	† Motorola	
	MC74153	Motorola	
	DM54153	† National	
	DM74153	National	
	54153	† Raytheon	
	74153	Raytheon	

(Continued)

Multiplexers (Cont'd)

Function	Device	Source	Line
Dual 4-Input Multiplexer (Continued)			130
	74153	Signetics	
	54153	† Signetics	
	SW74153	SW	
	TL74153	Telefunken	
	SN54153	† TI	
	SN74153	TI	
	74153	TRW	
TTL-LS	AM25LS153C	AMD	140
	AM25LS153M	† AMD	
	SN54LS153	† AMD	
	SN74LS153	AMD	
	9LS153C	Fairchild	
	9LS153M	† Fairchild	
	54LS153	† Fairchild	
	74LS153	Fairchild	
	DM54LS153	† National	
	DM74LS153	National	
	9LS153C	**Raytheon (258)**	150
	9LS153M	**† Raytheon (258)**	
	54LS153	**† Raytheon (258)**	
	74LS153	**Raytheon (258)**	
	25LS153C	**Raytheon (336)**	
	25LS153M	**† Raytheon (336)**	
	54LS153	† Signetics	
	74LS153	Signetics	
	SN54LS153	† TI	
	SN74LS153	TI	
TTL-S	SN54S153	† AMD	160
	SN74S153	AMD	
	54S153	† Fairchild	
	74S153	Fairchild	
	DM74S153	National	
	74S153	Signetics	
	SN54S153	† TI	
	SN74S153	TI	
Dual 4-Input Multiplexer (Three-State 54/75153)			
TTL	DM7214	† National	170
	DM8214	National	
Dual 4-Input Multiplexer, Three-State			
TTL-LS	AM25LS253C	AMD	
	AM25LS253M	† AMD	
	SN54LS253	† AMD	
	SN74LS253	AMD	
	9LS253C	Fairchild	
	9LS253M	† Fairchild	
	54LS253	† Fairchild	
	74LS253	Fairchild	180
	DM54LS253	† National	
	DM74LS253	National	
	9LS253C	**Raytheon (312)**	
	9LS253M	**† Raytheon (312)**	
	54LS253	**† Raytheon (312)**	
	74LS253	**Raytheon (312)**	
	25LS253C	**Raytheon (336)**	
	25LS253M	**† Raytheon (336)**	
	74LS253	Signetics	
	54LS253	† Signetics	190
	SN54LS253	† TI	
	SN74LS253	TI	
TTL-S	SN54S253	† AMD	

(Continued)

† Military Temperature Range (−55°C to 125°C)

IC MASTER

DIGITAL—TTL (Cont'd)

Multiplexers (Cont'd)

Function	Device	Source	Line
Dual 4-Input Multiplexer, Three-State (Continued)			
	SN74S253	AMD	
	54S253	† Fairchild	
	74S253	Fairchild	
	DM74S253	National	
	74S253	Signetics	
Dual 4-Input Multiplexer, Inverting			
TTL-LS	SN54LS352	† TI	10
	SN74LS352	TI	
Dual 4-Input Multiplexer, Complementary Output			
TTL	9309C	AMD	
	9309M	† AMD	
	9309C	Fairchild	
	9309M	† Fairchild	
	ITT9309-1	† ITT	
	ITT9309-5	ITT	
	MC8309	Motorola	20
	MC9309	† Motorola	
	DM8309	National	
	DM9309	National	
	N9309	Signetics	
	S9309	† Signetics	
	SN29309	TI	
	SN39309	† TI	
8-Input Multiplexer, Inverted Output			
TTL	54152	† Fairchild	
	74152	Fairchild	30
	MC54152	† Motorola	
	MC74152	Motorola	
	DM7210	† National	
	DM7211	† National	
	DM8210	National	
	DM8211	National	
	54152	† Raytheon	
	74152	Raytheon	
	74LS152	Signetics	
	54152	† Signetics	40
	SN54152A	† TI	
	74152	TRW	
TTL-LS	9LS152C	Fairchild	
	9LS152M	† Fairchild	
	54LS152	† Fairchild	
	74LS152	Fairchild	
	9LS152C	**Raytheon (256)**	
	9LS152M	**† Raytheon (256)**	
	54LS152	**† Raytheon (256)**	
	74LS152	**Raytheon (256)**	50
	SN54LS152	† TI	
	SN74LS152	TI	
8-Input Multiplexer, Complementary Output			
TTL	9312C	AMD	
	9312M	† AMD	
	9312C	Fairchild	
	9312M	† Fairchild	
	ITT9312-1	† ITT	
	ITT9312-5	ITT	
	MC8312	Motorola	60
	MC9312	† Motorola	
	DM8312	National	
	DM9312	† National	
	(Continued)		

Function	Device	Source	Line
8-Input Multiplexer, Complementary Output (Continued)			
	RC8230	Raytheon	
	RC8232	Raytheon	
	RC9312	Raytheon	70
	RM8230	† Raytheon	
	RM8232	† Raytheon	
	RM9312	† Raytheon	
	N8230	Signetics	
	N8232	Signetics	
	S8230	† Signetics	
	S8232	† Signetics	
	N9312	Signetics	
	SN29312	TI	
	SN39312	† TI	80
TTL-S	N82S30	Signetics	
	N82S31	Signetics	
	N82S32	Signetics	
8-Input Multiplexer, Complementary Output, Strobe			
TTL	54151	† Fairchild	
	74151	Fairchild	
	ZN54151	† Ferranti	
	ZN74151	Ferranti	
	HD2549	Hitachi	90
	HD2571	Hitachi	
	HD74151	Hitachi	
	ITT54151	† ITT	
	ITT74151	ITT	
	MC54151	† Motorola	
	MC74151	Motorola	
	DM54151A	† National	
	DM74151A	National	
	54151	† Raytheon	
	74151	Raytheon	100
	74151	Signetics	
	54151	† Signetics	
	SW74151	SW	
	TL74151	Telefunken	
	SN54151A	† TI	
	SN74151A	TI	
	74151	TRW	
TTL-LS	AM25LS151C	AMD	
	AM25LS151M	† AMD	
	SN54LS151	† AMD	110
	SN74LS151	AMD	
	9LS151C	Fairchild	
	9LS151M	† Fairchild	
	54LS151	† Fairchild	
	74LS151	Fairchild	
	DM54LS151	† National	
	DM74LS151	National	
	9LS151C	**Raytheon (256)**	
	9LS151M	**Raytheon (256)**	
	54LS151	**† Raytheon (256)**	120
	74LS151	**Raytheon (256)**	
	25LS151C	**Raytheon (334)**	
	25LS151M	**† Raytheon (334)**	
	74LS151	Signetics	
	54LS151	† Signetics	
	SN54LS151	† TI	
	SN74LS151	TI	
TTL-S	SN54S151	† AMD	
	SN74S151	AMD	
	(Continued)		130

Function	Device	Source	Line
8-Input Multiplexer, Complementary Output, Strobe (Continued)			
	54S151	† Fairchild	
	74S151	Fairchild	
	93S12C	Fairchild	
	93S12M	† Fairchild	
	HD74S151	Hitachi	
	DM74S151	National	
	74S151	Signetics	140
	SN54S151	† TI	
	SN74S151	TI	
8-Input Multiplexer, Complementary Output (Three-State 54/74151)			
TTL	DM7121	† National	
	DM8121	National	
8-Input Multiplexer, Complementary Output, Open Collector			
TTL	9313C	Fairchild	
	9313M	† Fairchild	150
	RC8231	Raytheon	
	RM8231	† Raytheon	
	N8231	Signetics	
	S8231	† Signetics	
8-Input Multiplexer, Strobe, Complementary Output, Three-State			
TTL	DM54251	† National	
	DM74251	National	
	SN54251	† TI	
	SN74251	TI	160
TTL-LS	AM25LS251C	AMD	
	AM25LS251M	† AMD	
	SN54LS251	† AMD	
	SN74LS251	AMD	
	9LS251C	Fairchild	
	9LS251M	† Fairchild	
	54LS251	† Fairchild	
	74LS251	Fairchild	
	DM54LS251	† National	
	DM74LS251	National	170
	9LS251C	**Raytheon (309)**	
	9LS251M	**† Raytheon (309)**	
	54LS251	**† Raytheon (309)**	
	74LS251	**Raytheon (309)**	
	25LS251C	**Raytheon (334)**	
	25LS251M	**† Raytheon (334)**	
	54LS251	† Signetics	
	74LS251	Signetics	
	SN54LS251	† TI	
	SN74LS251	TI	180
TTL-S	SN54S251	† AMD	
	SN74S251	AMD	
	54S251	† Fairchild	
	74S251	Fairchild	
	HD74S251	Hitachi	
	DM74S251	National	
	74S251	Signetics	
	SN54S251	† TI	
	SN74S251	TI	
Dual 8-Input Multiplexer (two 8-to-1 sections)			190
TTL	SN74351	TI	
16-Input Multiplexer, Inverted Output, Strobe			
TTL	54150	† Fairchild	
	(Continued)		

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Multiplexers (Cont'd)

Function	Device	Source	Line
16-Input Multiplexer, Inverted Output, Strobe (Continued)			
	74150	Fairchild	
	ZN54150	† Ferranti	
	ZN74150	Ferranti	
	HD2548	Hitachi	
	HD74150	Hitachi	
	ITT54150	† ITT	
	ITT74150	ITT	10
	MC54150	† Motorola	
	MC74150	Motorola	
	DM54150	† National	
	DM74150	National	
	54150	† Raytheon	
	74150	Raytheon	
	74150	Signetics	
	54150	† Signetics	
	SW74150	SW	
	TL74150	Telefunken	20
	SN54150	† TI	
	SN74150	TI	
	74150	TRW	
16-Input Multiplexer (Three-State 54/74150)			
TTL	DM7219	† National	
	DM8219	National	

Multivibrators

Function	Device	Source	Line
Monostable Multivibrator, Schmitt Trigger Input			
TTL	54121	† Fairchild	30
	74121	Fairchild	
	ZN54121	† Ferranti	
	ZN74121	Ferranti	
	HD2543	Hitachi	
	HD74121	Hitachi	
	ITT54121	† ITT	
	ITT74121	ITT	
	MC54121	† Motorola	
	MC74121	Motorola	
	DM54121	† National	40
	DM74121	National	
	74121	Signetics	
	54121	† Signetics	
	SW74121	SW	
	TL74121	Telefunken	
	SN54121	† TI	
	SN74121	TI	
	TD34121	Toshiba	
	74121	TRW	
Retriggerable Monostable Multivibrator			50
TTL	9601C	AMD	
	9601M	† AMD	
	9601C	Fairchild	
	9601M	† Fairchild	
	ITT9601-1	ITT	
	ITT9601-5	† ITT	
	MC8601	Motorola	
	MC9601	† Motorola	
	DM8601	National	
	DM9601	† National	60
	RF8601	Raytheon	
	RF9601	† Raytheon	
	RC8T22	Raytheon	

(Continued)

Multivibrators (Cont'd)

Function	Device	Source	Line
Retriggerable Monostable Multivibrator (Continued)			
	RM8T22	† Raytheon	
	N8T22	Signetics	
	N9601	Signetics	70
	SW9601	SW	
	SN29601	TI	
Retriggerable Monostable Multivibrator, with Reset			
TTL	9600C	AMD	
	9600M	† AMD	
	AM2600C	AMD	
	AM2600M	† AMD	
	9600C	Fairchild	
	9600M	† Fairchild	80
Retriggerable Monostable Multivibrator with Clear			
TTL	54122	† Fairchild	
	74122	Fairchild	
	ZN54122	† Ferranti	
	ZN74122	Ferranti	
	ITT54122	† ITT	
	ITT74122	ITT	
	74122	Signetics	
	SW74122	SW	90
	TL74122	Telefunken	
	SN54122	† TI	
	SN74122	TI	
TTL-LS	DM54LS122	† National	
	DM74LS122	National	
	SN54LS122	† TI	
	SN74LS122	TI	
Bidirectional Monostable Multivibrator (Low Level Input)			
TTL	RC8T20	Raytheon	100
	RM8T20	† Raytheon	
	N8T20	Signetics	
	S8T20	† Signetics	
Dual Monostable Multivibrator, Schmitt-Trigger Input (Dual 54/74121)			
TTL	SN54221	† AMD	
	SN74221	AMD	
	74221	Signetics	
	54221	† Signetics	
	SN54221	† TI	110
	SN74221	TI	
TTL-LS	DM54LS221	† National	
	DM74LS221	National	
	74LS221	Signetics	
	54LS221	† Signetics	
	SN54LS221	TI	
	SN74LS221	TI	
Dual Retriggerable Monostable Multivibrator with Reset (OR Triggered)			
TTL	AM2602C	AMD	120
	AM2602M	† AMD	
	9602C	AMD	
	9602M	† AMD	
	96L02C	Fairchild	
	96L02M	† Fairchild	
	9602C	Fairchild	
	9602M	† Fairchild	

(Continued)

Multivibrators (Cont'd)

Function	Device	Source	Line
Dual Retriggerable Monostable Multivibrator with Reset (OR Triggered) (Continued)			130
	ITT9602-1	† ITT	
	ITT9602-5	ITT	
	MC8602	Motorola	
	MC9602	† Motorola	
	DM8602	National	
	DM9602	† National	
	RF8602	Raytheon	
	RF9602	† Raytheon	
	N9602	Signetics	140
	S9602	† Signetics	
	SW9602	SW	
TTL-S	AM26S02C	AMD	
	AM26S02M	† AMD	
	96S02C	Fairchild	
	96S02M	† Fairchild	
Dual Retriggerable Monostable Multivibrator with Clear (AND Triggered)			
TTL	AM26123C	AMD	
	AM26123M	† AMD	150
	SN54123	† AMD	
	SN74123	AMD	
	54123	† Fairchild	
	74123	Fairchild	
	ZN54123	† Ferranti	
	ZN74123	Ferranti	
	HD2561	Hitachi	
	DM54123	† National	
	DM74123	National	
	54123	† Raytheon	160
	74123	Raytheon	
	74123	Signetics	
	54123	† Signetics	
	SW74123	SW	
	TL74123	Telefunken	
	SN54123	† TI	
	SN74123	TI	
	74123	TRW	
TTL-LS	AM25LS123C	AMD	
	AM25LS123M	† AMD	170
	SN54LS123	† AMD	
	SN74LS123	AMD	
	DM54LS123	† National	
	DM74LS123	National	
	SN54LS123	† TI	
	SN74LS123	TI	
Dual Monostable Multivibrator (Double-Edge)			
TTL	DM7853	† National	
	DM8853	National	
Dual Voltage-Controlled Multivibrator			180
TTL	11C24C	Fairchild	
	MC4024	Motorola	
	MC4324	† Motorola	
Universal Pulse Generator			
TTL	ITT54124	† ITT	
	ITT74124	ITT	

† Military Temperature Range (−55°C to 125°C)

DIGITAL—TTL (Cont'd)

Shift Registers

4-Bit Parallel Input, Parallel Output Shift Register

Function	Device	Source	Line
TTL	9300C	AMD	
	9300M	† AMD	
	SN54195	† AMD	
	SN74195	AMD	
	9300C	Fairchild	
	9300M	† Fairchild	
	54195	† Fairchild	10
	74195	Fairchild	
	ITT9300-1	† ITT	
	ITT9300-5	ITT	
	ITT54195	† ITT	
	ITT74195	ITT	
	MC8300	Motorola	
	MC9300	† Motorola	
	MC54195	† Motorola	
	MC74195	Motorola	
	DM8300	National	20
	DM9300	† National	
	DM54195	† National	
	DM74195	National	
	RC9300	Raytheon	
	RM9300	† Raytheon	
	54195	† Raytheon	
	74195	Raytheon	
	N9300	Signetics	
	S9300	† Signetics	
	74195	Signetics	30
	54195	† Signetics	
	TL74195	Telefunken	
	SN29300	TI	
	SN39300	† TI	
	SN54195	† TI	
	SN74195	TI	
TTL-LS	AM25LS195AC	AMD	
	AM25LS195AM	† AMD	
	SN54LS195A	† AMD	
	SN74LS195A	AMD	40
	9LS195C	Fairchild	
	9LS195M	† Fairchild	
	54LS195	† Fairchild	
	74LS195	Fairchild	
	DM54LS195	† National	
	DM74LS195	National	
	9LS195AC	**Raytheon (302)**	
	9LS195AM	**† Raytheon (302)**	
	54LS195A	**† Raytheon (302)**	
	74LS195A	**Raytheon (302)**	50
	25LS195AC	**Raytheon (355)**	
	25LS195AM	**† Raytheon (355)**	
	74LS195A	Signetics	
	54LS195A	† Signetics	
	SN54LS195A	† TI	
	SN74LS195A	TI	
TTL-S	SN54S195	† AMD	
	SN74S195	AMD	
	93S00C	Fairchild	
	93S00M	† Fairchild	60
	54S195	Fairchild	
	74S195	Fairchild	
	DM74S195	National	
	74S179	Signetics	
	74S178	Signetics	

(Continued)

Shift Registers (Cont'd)

4-Bit Parallel Input, Parallel Output Shift Register (Continued)

Function	Device	Source	Line
	74S195	Signetics	70
	N82S70	Signetics	
	N82S71	Signetics	
	SN54S195	† TI	
	SN74S195	TI	

4-bit Parallel-In, Parallel Out, Right/Left Shift Register

Function	Device	Source	Line
TTL	5495	† Fairchild	
	7494	Fairchild	
	ZN5495A	† Ferranti	
	ZN7495A	Ferranti	80
	HD2534	Hitachi	
	ITT5495	† ITT	
	ITT7495	ITT	
	MC4012	Motorola	
	MC5495	† Motorola	
	MC7495	Motorola	
	DM5495	† National	
	DM7495	National	
	7495	Signetics	
	5495	† Signetics	90
	SW7495	SW	
	TL7495	Telefunken	
	SN5495A	† TI	
	SN7495A	TI	
	TD3495	Toshiba	
TTL-LS	9LS95C	Fairchild	
	9LS95M	† Fairchild	
	54LS95	† Fairchild	
	74LS95	Fairchild	
	DM54LS95B	† National	100
	DM74LS95B	National	
	54LS95B	† Raytheon	
	74LS95B	Signetics	
	54LS95B	† Signetics	
	SN54LS95B	† TI	
	SN74LS95B	TI	

4-bit Universal Bidirectional Shift Register

Function	Device	Source	Line
TTL	SN54194	† AMD	
	SN74194	AMD	
	54194	† Fairchild	110
	74194	Fairchild	
	ZN54194	† Ferranti	
	ZN74194	Ferranti	
	HD74194	Hitachi	
	ITT54194	† ITT	
	ITT74194	ITT	
	DM54194	† National	
	DM74194	National	
	54194	† Raytheon	
	74194	Raytheon	120
	74194	Signetics	
	54194	† Signetics	
	TL74194	Telefunken	
	SN54194	† TI	
	SN74194	TI	
TTL-LS	AM25LS194AC	AMD	
	AM25LS194AM	† AMD	
	SN54LS194A	† AMD	
	SN74LS194A	AMD	
	9LS194C	Fairchild	130

(Continued)

Shift Registers (Cont'd)

4-bit Universal Bidirectional Shift Register (Continued)

Function	Device	Source	Line
	9LS194M	† Fairchild	
	54LS194	† Fairchild	
	74LS194	Fairchild	
	DM54LS194	† National	
	DM74LS194	National	
	9LS194AC	**Raytheon (299)**	140
	9LS194AM	**† Raytheon (299)**	
	54LS194A	**† Raytheon (299)**	
	74LS194A	**Raytheon (299)**	
	25LS194AC	**Raytheon (355)**	
	25LS194AM	**† Raytheon (355)**	
	74LS194A	Signetics	
	54LS194A	Signetics	
	SN54LS194A	† TI	
	SN74LS194A	TI	
TTL-S	SN54S194	† AMD	150
	SN74S194	AMD	
	54S194	† Fairchild	
	74S194	Fairchild	
	74S194	Signetics	
	SN54S194	† TI	
	SN74S194	TI	

4-bit Parallel In, Parallel Out, Right/Left Shift Register, Three-State

Function	Device	Source	Line
TTL-LS	9LS295C	Fairchild	
	9LS295M	† Fairchild	160
	54LS295	† Fairchild	
	74LS295	Fairchild	
	DM54LS245A	† National	
	DM74LS295A	National	
	9LS295AC	**Raytheon (321)**	
	9LS295AM	**† Raytheon (321)**	
	54LS295A	**† Raytheon (321)**	
	74LS295A	**Raytheon (321)**	
	74LS295A	Signetics	
	54LS295A	† Signetics	170
	SN54LS295A	† TI	
	SN74LS295A	TI	

4-bit Parallel-In, Parallel-Out, Cascadable Shift Register, Three-State

Function	Device	Source	Line
TTL-LS	54LS395	† Fairchild	
	74LS395	Fairchild	
	DM54LS395	† National	
	DM74LS395	National	
	9LS395C	**Raytheon (327)**	
	9LS395M	**† Raytheon (327)**	180
	54LS395	**† Raytheon (327)**	
	74LS395	**Raytheon (327)**	
	SN54LS395	† TI	
	SN74LS395	TI	

4-bit Parallel-In, Serial-Out, Shift Register

Function	Device	Source	Line
TTL	5494	† Fairchild	
	7494	Fairchild	
	ZN5494	† Ferranti	
	ZN7494	Ferranti	
	HD2533	Hitachi	190
	ITT5494	† ITT	
	ITT7494	ITT	
	MC5494	† Motorola	
	MC7494	Motorola	
	7494	Signetics	

(Continued)

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL (Cont'd)

Shift Registers (Cont'd)

Function	Device	Source	Line
4-bit Parallel-In, Serial-Out, Shift Register (Continued)			
	5494	† Signetics	
	SW7494	SW	
	TL7494	Telefunken	
	SN5494	† TI	
	SN7494	TI	
4-bit Parallel-In, Serial-Out, Shift Register, (with load, shift, hold control)			10
TTL	54178	† Fairchild	
	74178	Fairchild	
	MC7270	Motorola	
	MC8270	† Motorola	
	RC8270	Raytheon	
	RM8270	† Raytheon	
	S8270	† Signetics	
	N8270	Signetics	
	TL74178	Telefunken	
	SN54178	† TI	20
	SN74178	TI	
4-bit Parallel-In, Serial-Out, Shift Register, with Reset, Complementary Output for last bit			
TTL	54179	† Fairchild	
	74179	Fairchild	
	MC7271	Motorola	
	MC8271	† Motorola	
	RC8271	Raytheon	
	RM8271	† Raytheon	30
	N8271	Signetics	
	S8271	† Signetics	
	TL74179	Telefunken	
	SN54179	† TI	
	SN74179	TI	
4-bit Universal Shift Register, Binary Up/ Down Counter, Synchronous			
TTL-S	SN74S291	TI	
5-bit Parallel-In, Parallel-Out, Shift Register			
TTL	5496	† Fairchild	40
	7496	Fairchild	
	ZN5496	† Ferranti	
	ZN7496	Ferranti	
	HD2546	Hitachi	
	HD7496	Hitachi	
	ITT5496	† ITT	
	ITT7496	ITT	
	MC5496	† Motorola	
	MC7496	Motorola	
	DM5496	† National	50
	DM7496	National	
	7496	Signetics	
	5496	† Signetics	
	SW7496	SW	
	TL7496	Telefunken	
	SN5496	† TI	
	SN7496	TI	
	7496	TRW	
TTL-LS	DM54LS96	† National	
	DM74LS96	National	60
	74LS96	Signetics	
	54LS96	† Signetics	
	SN54LS96	† TI	
	SN74LS96	TI	

Shift Registers (Cont'd)

Function	Device	Source	Line
8-bit Parallel-In, Parallel-Out, Unidirectional Shift Register			
TTL	54199	† Fairchild	
	74199	Fairchild	
	HDP4199	Hitachi	70
	DM54199	† National	
	DM74199	National	
	54199	† Raytheon	
	74199	Raytheon	
	74199	Signetics	
	54199	† Signetics	
	TL74199	Telefunken	
	SN54199	† TI	
	SN74199	TI	
8-bit Parallel-In, Parallel-Out, Right/Left Shift Register			80
TTL	54198	† Fairchild	
	74198	Fairchild	
	HD74198	Hitachi	
	DM54198	† National	
	DM74198	National	
	54198	† Raytheon	
	74198	Raytheon	
	74198	Signetics	
	54198	† Signetics	90
	TL74198	Telefunken	
	SN54198	† TI	
	SN74198	TI	
8-bit Universal Shift Register, Three-State			
TTL	DM7546	† National	
	DM8546	National	
TTL-LS	AM25LS23C	AMD	
	AM25LS23M	† AMD	
	AM25LS299C	AMD	
	AM25LS299M	† AMD	100
	SN54LS299	† AMD	
	SN74LS299	AMD	
	25LS299C	**Raytheon (361)**	
	25LS299M	**† Raytheon (361)**	
	SN54LS299	† TI	
	SN74LS299	TI	
	SN54LS322	† TI	
	SN74LS322	TI	
	SN54LS323	† TI	
	SN74LS323	TI	110
TTL-S	SN74S299	TI	
8-bit Parallel-In, Serial-Out Shift Register, Complementary Output			
TTL	54165	† Fairchild	
	74165	Fairchild	
	ZN54165	† Ferranti	
	ZN74165	Ferranti	
	DM54165	† National	
	DM74165	National	
	54165	† Raytheon	120
	74165	Raytheon	
	74165	Signetics	
	54165	† Signetics	
	TL74165	Telefunken	
	SN54165	† TI	
	SN74165	TI	
TTL-LS	54LS165	† Fairchild	
	(Continued)		

Shift Registers (Cont'd)

Function	Device	Source	Line
8-bit Parallel-In, Serial-Out Shift Register, Complementary Output (Continued)			130
	74LS165	Fairchild	
	SN54LS165	† TI	
	SN74LS165	TI	
8-bit Parallel-In, Serial-Out Shift Register with Clear			
TTL	54166	† Fairchild	
	74166	Fairchild	
	ZN54166	† Ferranti	
	ZN74166	Ferranti	140
	HD74166	Hitachi	
	DM54166	† National	
	DM74166	National	
	54166	† Raytheon	
	74166	Raytheon	
	74166	Signetics	
	54166	† Signetics	
	TL74166	Telefunken	
	SN54166	† TI	
	SN74166	TI	150
TTL-LS	SN54LS166	† TI	
	SN74LS166	TI	
8-bit Gated Serial-In, Parallel-Out Shift Register			
TTL	SN54164	† AMD	
	SN74164	AMD	
	54164	† Fairchild	
	74164	Fairchild	
	ZN54164	† Ferranti	
	HD74164	Hitachi	160
	ZN74164	Ferranti	
	ITT54164	† ITT	
	ITT74164	ITT	
	MC54164	† Motorola	
	MC74164	Motorola	
	DM7570	† National	
	DM8570	National	
	DM54164	† National	
	DM74164	National	
	54164	† Raytheon	170
	74164	Raytheon	
	74164	Signetics	
	54164	† Signetics	
	TL74164	Telefunken	
	SN54164	† TI	
	SN74164	TI	
	TD3503	Toshiba	
TTL-LS	AM25LS164C	AMD	
	AM25LS164M	AMD	
	SN54LS164	† AMD	180
	SN74LS164	AMD	
	9LS164C	Fairchild	
	9LS164M	† Fairchild	
	54LS164	† Fairchild	
	74LS164	Fairchild	
	DM54LS164	† National	
	DM74LS164	National	
	9LS164C	**Raytheon (271)**	
	9LS164M	**† Raytheon (271)**	
	54LS164	**† Raytheon (271)**	190
	74LS164	**Raytheon (271)**	
	74LS164	Signetics	
	(Continued)		

† Military Temperature Range (−55°C to 125°C)

DIGITAL—TTL (Cont'd)

Shift Registers (Cont'd)

Function	Device	Source	Line
8-bit Gated Serial-In, Parallel-Out Shift Register (Continued)			
	54LS164	† Signetics	
	SN54LS164	† TI	
	SN74LS164	TI	
8-bit Serial-In, Serial-Out Shift Register			
TTL	5491	† Fairchild	
	7491	Fairchild	
	ZN5491	† Ferranti	10
	ZN7491	Ferranti	
	HD2524	Hitachi	
	ITT5491A	† ITT	
	ITT7491A	ITT	
	MC5491	† Motorola	
	MC7491	Motorola	
	DM5491A	† National	
	DM7491A	National	
	7491	Signetics	
	N8276	Signetics	20
	5491	† Signetics	
	SW7491	SW	
	TL7491	Telefunken	
	SN5491A	† TI	
	SN7491A	TI	
	TD3491	Toshiba	
TTL-LS	SN54LS91	† TI	
	SN74LS91	TI	
8-bit Serial/Parallel-In Register with Sign Extend (for use with 25LS14/74LS384, Multiplier)			30
TTL-LS	AM25LS22C	AMD	
	AM25LS22M	† AMD	
	SN54LS322	† TI	
	SN74LS322	TI	
10-bit Parallel-In, Parallel-Out Buffer Register, with Reset (clocked flip-flops)			
TTL	RC8202	Raytheon	
	RM8202	† Raytheon	
	N8202	Signetics	40
	S8202	† Signetics	
10-bit Parallel-In, Parallel-Out Buffer Register, with Reset, Inverting Output (clocked flip-flops)			
TTL	RC8203	Raytheon	
	RM8203	† Raytheon	
	N8203	Signetics	
	S8203	† Signetics	
10-bit Parallel-In, Serial-Out Shift Register			
TTL	RC8274	Raytheon	50
	RM8274	† Raytheon	
	N8274	Signetics	
	S8274	Signetics	
10-bit Serial-In, Parallel-Out Shift Register			
TTL	RC8273	Raytheon	
	RM8273	† Raytheon	
	N8273	Signetics	
	S8273	† Signetics	
Dual 5-bit Parallel-In, Parallel-Out Buffer Register, (clocked flip-flops)			60
TTL	RC8200	Raytheon	
	RM8200	† Raytheon	
	N8200	Signetics	

(Continued)

Shift Registers (Cont'd)

Function	Device	Source	Line
Dual 5-bit Parallel-In, Parallel-Out Buffer Register, (clocked flip-flops) (Continued)			
	S8200	† Signetics	
Dual 5-bit Parallel-In, Parallel-Out, Buffer Register, Inverting Output (clocked flip-flops)			70
TTL	RC8201	Raytheon	
	RM8201	† Raytheon	
	N8201	Signetics	
	S8201	† Signetics	
Dual 8-bit Serial-In, Serial-Out, Shift Register			
TTL	9328C	AMD	
	9328M	† AMD	
	9328C	Fairchild	
	9328M	† Fairchild	
	ITT9328-1	† ITT	80
	ITT9328-5	ITT	
	MC8328	Motorola	
	MC9328	† Motorola	
	RC8277	Raytheon	
	RM8277	† Raytheon	
	N8277	Signetics	
4-bit Shifter, Three-State (Shifts 0, 1, 2, or 3-bits Under 2-Line Select Control)			
TTL-S	AM25S10C	AMD	
	AM25S10M	† AMD	90

Translators

Function	Device	Source	Line
Hex DTL to TTL Inverter			
TTL	9109C	Fairchild	
	9109M	† Fairchild	
Hex TTL to DTL Inverter			
TTL	9112C	Fairchild	
	9112M	† Fairchild	
Dual MOS to TTL Level Converter			
TTL	9625C	Fairchild	
	9625M	† Fairchild	100
Dual MOS to TTL Level Translator, Three-State			
TTL	MC54468	† Motorola	
	MC74468	Motorola	
7-Unit MOS to TTL Level Converter			
TTL	SN75270	TI	
Dual 2-Input NAND Gate, High Voltage to TTL Interface, to 30v Input			
TTL	N8T18	Signetics	
	S8T18	† Signetics	110
Dual TTL to MOS Voltage Translator			
TTL	D130A	† Siliconix	
	D130B	Siliconix	
	D139A	† Siliconix	
	D139B	Siliconix	
Dual 2-Input NAND TTL to MOS Voltage Translator			
TTL	9624C	Fairchild	
	9624M	† Fairchild	
	DH0034	† National	120
	DH0034C	National	
	DS7800	† National	
	DS8800	National	

(Continued)

Translators (Cont'd)

Function	Device	Source	Line
Dual 2-Input NAND TTL to MOS Voltage Translator (Continued)			
	SN55180	† TI	
	SN75180	TI	
Hex TTL to MOS Voltage Translator			130
TTL	DS7812	† National	
	DS8812	National	
	DS78L12	† National	
	DS88L12	National	
	D123A	† Siliconix	
	D123B	Siliconix	
	D125A	† Siliconix	
	D125B	Siliconix	
Quad 2-Input NAND TTL to MOS Voltage Translators			140
TTL	DS7810	† National	
	DS8810	National	
	DS7811	† National	
	DS8811	National	
Quad 2-Input AND TTL to MOS Voltage Translators			
TTL	DS7819	† National	
	DS8819	National	
Dual ECL to MOS Driver (also ECL to TTL)			
TTL	MC75358	Motorola	150
	MC75368	Motorola	
	SN75368	TI	
Quad TTL to CMOS Inverter/Driver, Three-State			
TTL	ITT75367	ITT	
	SN75367	TI	
For other translators, see Interface-Sense Amplifiers			

Miscellaneous

Function	Device	Source	Line
Programmable Logic Array (mask programmed) (see also Memory-PLAs)			160
TTL	**DM7575**	**† National (739)**	
	DM7576	**† National (739)**	
	DM8575	**National (739)**	
	DM8576	**National (739)**	
TTL-S	N82S200	Signetics	
	N82S201	Signetics	
Programmable Logic Arrays, Field Programmable (See also Memory-PLAs)			170
TTL	IM5200	Intersil	
	HM7660	Harris	
	HM7661	Harris	
TTL-S	N82S100	Signetics	
	S82S100	† Signetics	
	N82S101	Signetics	
	S82S101	† Signetics	
	SN54S330	**† TI (1100)**	
	SN74S330	**TI (1100)**	
	SN54S331	**† TI (1101)**	
	SN74S331	**TI (1101)**	180
4-bit True/Complement Zero/One Element			
TTL-H	54H87	† Fairchild	
	74H87	Fairchild	
	TL74H87	Telefunken	

(Continued)

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

DIGITAL—TTL (Cont'd)

Miscellaneous (Cont'd)

Function	Device	Source	Line
4-bit True/Complement Zero/One Element (Continued)			
	SN54H87	† TI	
	SN74H87	TI	
Dual 4-Input Expander (for H50, H53, H55)			
TTL-H	54H60	† Fairchild	
	74H60	Fairchild	
	ITT54H60	† ITT	
	ITT74H60	ITT	10
	MC3030	Motorola	
	MC3130	† Motorola	
	DM54H60	† National	
	DM74H60	National	
	54H60	† Signetics	
	74H60	Signetics	
	SN54H60	† TI	
	SN74H60	TI	
Triple 3-Input Expander (for H52)			
TTL-H	54H61	† Fairchild	20
	74H61	Fairchild	
	MC3019	Motorola	
	MC3119	† Motorola	
	DM54H61	National	
	54H61	† Signetics	
	74H61	Signetics	
	SN54H61	† TI	
	SN74H61	TI	
3-2-2-3-Input AND-OR Expander (for H50, H53, H55)			30
TTL-H	54H62	† Fairchild	
	74H62	Fairchild	
	MC3018	Motorola	
	MC3118	† Motorola	
	DM54H62	† National	
	DM74H62	National	
	54H62	† Signetics	
	74H62	Signetics	
	SN54H62	† TI	
	SN74H62	TI	40
8-bit Successive Approximation Register			
TTL	AM2502C	AMD	
	AM2502M	† AMD	
	AM2503C	AMD	
	AM2503M	† AMD	
	DM2502	† National	
	DM2502C	National	
	DM2503	† National	
	DM2503C	National	
12-bit Successive Approximation Register			50
TTL	AM2504C	AMD	
	AM2504M	† AMD	
	DM2504	† National	
	DM2504C	National	
8-bit Position Scaler (The output is shifted with respect to the input up to 8 positions as determined by a 3-bit selector code.)			
TTL	RC8243	Raytheon	
	RM8243	† Raytheon	
	N8243	Signetics	60
	S8243	† Signetics	

Miscellaneous (Cont'd)

Function	Device	Source	Line
6-bit Synchronous Binary Rate Multiplier			
TTL	5497	† Fairchild	
	7497	Fairchild	
	TL7497	Telefunken	
	SN5497	† TI	
	SN7497	TI	
Synchronous Decade Rate Multiplier			
TTL	TL74167	Telefunken	70
	SN54107	† TI	
	SN74167	TI	
TTL-S	54S167	† Fairchild	
	74S167	Fairchild	
4-bit Priority Register, Cascadable			
TTL	TL74278	Telefunken	
	SN54278	† TI	
	SN74278	TI	
TTL-LS	SN54LS278	† TI	
	SN74LS278	TI	80
8-Input Priority Encoder			
TTL	9318C	AMD	
	9318M	† AMD	
	9318C	Fairchild	
	9318M	† Fairchild	
	HD74148	Hitachi	
	MC8318	Motorola	
	MC9318	† Motorola	
	DM8318	National	
	DM9318	† National	90
	DM54148	† National	
	DM74148	National	
	74148	Signetics	
	54148	† Signetics	
	TL74148	Telefunken	
	SN29318	TI	
	SN39318	† TI	
	SN54148	† TI	
	SN74148	TI	
TTL-LS	AM2913C	AMD	100
	AM2913M	† AMD	
	AM25LS148C	AMD	
	AM25LS148M	† AMD	
	SN54LS148	† AMD	
	SN74LS148	AMD	
10-Input Priority Encoder			
TTL	HD74147	Hitachi	
	DM54147	† National	
	DM74147	National	
	74147	Signetics	110
	54147	† Signetics	
	TL74147	Telefunken	
	SN54147	† TI	
	SN74147	TI	
8-bit Parity Tree			
TTL	MC4008	Motorola	
	MC4308	† Motorola	
	MC54408	† Motorola	
	MC74408	Motorola	
Dual 4-bit Parity Tree			120
TTL	MC4010	Motorola	
	MC4310	† Motorola	

Miscellaneous (Cont'd)

Function	Device	Source	Line
9-bit Parity Generator/Checker			
TTL	DM7220	† National	
	DM8220	National	
9-bit Odd/Even Parity Generator/Checker			
TTL	54180	† Fairchild	
	74180	Fairchild	
	ZN54180	† Ferranti	130
	ZN74180	Ferranti	
	HD2525	Hitachi	
	HD74180	Hitachi	
	ITT54180	† ITT	
	ITT74180	ITT	
	MC54180	† Motorola	
	MC74180	Motorola	
	DM54180	† National	
	DM74180	National	
	54180	† Raytheon	140
	74180	Raytheon	
	RC8262	Raytheon	
	RM8262	† Raytheon	
	N8262	Signetics	
	S8262	† Signetics	
	54180	† Signetics	
	74180	Signetics	
	SW74180	SW	
	TL7480	Telefunken	
	SN54180	† TI	150
	SN74180	TI	
	74180	TRW	
	SN74LS280	TI	
	SN74LS180	TI	
TTL-S	82S62C	AMD	
	82S62M	† AMD	
	93S62C	Fairchild	
	93S62M	† Fairchild	
	DM74S280	National	
	74S280	Signetics	160
	N82S62	Signetics	
	SN54S280	† TI	
	SN74S280	TI	
12-Input Odd/Even Parity Checker/Generator			
TTL	9348C	Fairchild	
	9348M	† Fairchild	
TTL-S	93S48C	AMD	
	93S48M	† AMD	
Cyclic Redundancy Checker			
TTL	9401C	Fairchild	170
	9401M	† Fairchild	
4-bit Universal Presettable Polynomial Generator			
TTL	MC8504	Motorola	
Polynomial Generator			
TTL	MC8506	Motorola	
Single Error Hamming Code Detector and Generator			
TTL	MC4041	Motorola	
BCD-To-Binary/Binary-To-BCD Number Converter			180
TTL	MC4001	Motorola	

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Miscellaneous (Cont'd)

Function	Device	Source	Line
BCD-To-Binary Converter			
TTL	ZN54184	† Ferranti	
	ZN74184	Ferranti	
	DM54184	† National	
	DM74184	National	
	TL74184	Telefunken	
	SN54184	† TI	
	SN74184	TI	
BCD-To-Binary Converter (Three-State 54/74184)			10
TTL	DM8898	National	
Binary-To-BCD Converter			
TTL	DM54185A	† National	
	DM74185A	National	
	DM8899	National	
	TL74185	Telefunken	
	SN54185A	† TI	
	SN74185A	TI	
Dual Pulse Synchronizer/Driver			20
TTL	SN54120	† TI	
	SN74120	TI	
Quad Power Strobe (V strobe or digit driver)			
TTL	HD6600-2	† Harris	
	HD6600-5	Harris	
	HD6605-2	† Harris	
	HD6605-5	† Harris	
Phase-Frequency Detector			
TTL	11C44C	Fairchild	30
	11C44M	† Fairchild	
	MC4044	Motorola	
	MC4344	† Motorola	
Contact Bounce Eliminator			
TTL	DM7544	† National	
	DM8544	National	
Quad Complementary-Output Elements (for symmetrical generation of complementary outputs)			
TTL	SN54265	† TI	40
	SN74265	TI	
Dual Zero Crossing Detector			
TTL	N8T363	Signetics	
	S8T363	† Signetics	
MOS Dynamic Memory Refresh Logic Circuit			
TTL	MC8505	Motorola	
Dual 4-Input NAND Schmitt-Trigger			
TTL	5413	† Fairchild	
	7413	Fairchild	
	ZN5413	† Ferranti	50
	ZN7413	Ferranti	
	HD2545	Hitachi	
	ITT5413	† ITT	
	ITT7413	ITT	
	DM5413	† National	
	DM7413	National	
	7413	Signetics	
	5413	† Signetics	
	SW7413	SW	
	SN5413	† TI	60
	SN7413	TI	

(Continued)

Miscellaneous (Cont'd)

Function	Device	Source	Line
Dual 4-Input NAND Schmitt-Trigger (Continued)			
	7413	TRW	
TTL-LS	DM54LS13	† National	
	DM74LS13	National	
	9LS13C	**Raytheon (218)**	
	9LS13M	**† Raytheon (218)**	70
	54LS13	**† Raytheon (218)**	
	74LS13	**Raytheon (218)**	
	74LS13	Signetics	
	54LS13	† Signetics	
	SN54LS13	† TI	
	SN74LS13	TI	
Quad 2-Input NAND Schmitt-Trigger			
TTL	54132	† Fairchild	
	74132	Fairchild	
	HD74132	Hitachi	80
	ITT54137	† ITT	
	ITT74137	ITT	
	DM54132	† National	
	DM74132	National	
	74132	Signetics	
	54132	† Signetics	
	TL74132	Telefunken	
	SN54132	† TI	
	SN74132	TI	
TTL-LS	9LS132C	Fairchild	90
	9LS132M	† Fairchild	
	54LS132	† Fairchild	
	74LS132	Fairchild	
	DM54LS132	† National	
	DM74LS132	National	
	74LS132	Signetics	
	54LS132	† Signetics	
	SN54LS132	† TI	
	SN74LS132	TI	
TTL-S	54S132	† Fairchild	100
	74S132	Fairchild	
	SN54S132	† TI	
	SN74S132	TI	
Quad 2-Input NOR Schmitt Trigger			
TTL	74232	Signetics	
	54232	† Signetics	
Hex Schmitt Trigger, Inverting			
TTL	5414	† Fairchild	
	7414	Fairchild	
	HD7414	Hitachi	110
	ITT54135	† ITT	
	ITT74135	ITT	
	DM5414	† National	
	DM7414	National	
	7414	Signetics	
	5414	† Signetics	
	TL7414	Telefunken	
	SN5414	† TI	
	SN7414	TI	
TTL-LS	9LS14C	Fairchild	120
	9LS14M	† Fairchild	
	54LS14	† Fairchild	
	74LS14	Fairchild	
	DM54LS14	† National	
	DM74LS14	National	

(Continued)

Miscellaneous (Cont'd)

Function	Device	Source	Line
Hex Schmitt Trigger, Inverting (Continued)			
	9LS14C	**Raytheon (218)**	
	9LS14M	**† Raytheon (218)**	130
	54LS14	**† Raytheon (218)**	
	74LS14	**Raytheon (218)**	
	74LS14	Signetics	
	54LS14	† Signetics	
	SN54LS14	† TI	
	SN74LS14	TI	
Voltage Controlled Oscillator (or Crystal Controlled)			
TTL-LS	SN54LS324	† TI	
	SN74LS324	TI	140
Dual Voltage Controlled Oscillator (or Crystal Controlled)			
TTL-LS	DM54LS124	† National	
	DM74LS124	National	
	SN54LS124	† TI	
	SN74LS124	TI	
	SN54LS325	† TI	
	SN74LS325	TI	
	SN54LS326	† TI	
	SN74LS326	TI	150
	SN54LS327	† TI	
	SN74LS327	TI	
TTL-S	SN54S124	† TI	
	SN74S124	TI	
Voltage Comparator (Analog Input-Digital Output)			
	686C	AMD	
	686M	† AMD	
Decade Sequencer (sequential 1 of 10 Decoder)			160
TTL	9319C	Fairchild	
	9319M	† Fairchild	
	9320C	Fairchild	
	9320M	† Fairchild	
Bus Transfer Switch (transmit-receive connections to 4 bus terminals)			
TTL	MC54460	† Motorola	
	MC74460	Motorola	
Triple Bidirectional Bus Switch, Three-State (Connects any 2 of 3 inputs togetther)			170
TTL-S	MC6881	Motorola	
	MC3449	Motorola	
Quad Bus Transceiver			
TTL-LS	SN54LS242	† TI	
	SN74LS242	TI	
	SN54LS243	† TI	
	SN74LS243	TI	
4-bit Parallel Bus Transceiver, Non-Inverting, Three-State			
TTL-S	MC8T28	Motorola	180
	N8T28	Signetics	
4-bit Parallel Universal Bus Transceiver, Storage, Three-State			
TTL-S	SN54S226	† TI	
	SN74S226	TI	
4-bit Parallel Bus Transceiver, Inverting Three-State			
TTL-S	N8T26	AMD	

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† Military Temperature Range (−55°C to 125°C)

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DIGITAL—TTL (Cont'd)

Miscellaneous (Cont'd)

Function	Device	Source	Line
4-bit Parallel Bus Transceiver, Inverting Three-State (Continued)			
	S8T26	† AMD	
	MC8T26	Motorola	
	N8T26	Signetics	
4-bit Parallel Bus Transceiver, Open Collector Drivers			
TTL-S	AM26S10C	AMD	
	AM26S10M	† AMD	10
	AM26S11C	AMD	
	AM26S11M	† AMD	
	AM26S12AC	AMD	
	AM26S12C	AMD	
	AM26S12AM	† AMD	
	AM26S12M	† AMD	
	9640C	Fairchild	
	9640M	† Fairchild	
	9641C	Fairchild	
	9641M	† Fairchild	20
8-bit Bidirection I/O Port			
	N8T31	Signetics	
Octal Bus Driver (Schmitt Trigger), Inverting, Three-State			
TTL-LS	AM25LS240C	AMD	
	AM25LS240M	† AMD	
	SN54LS240	† AMD	
	SN74LS240	AMD	
	74LS240	Fairchild	
	SN54LS240	† TI	30
	SN74LS240	TI	
TTL-S	SN74S240	TI	
Octal Bus Driver (Schmitt Trigger), Non-Inverting, Three-State			
TTL-LS	AM25LS241C	AMD	
	AM25LS241M	† AMD	
	SN54LS241	AMD	
	SN74LS241	AMD	
	54LS241	† Fairchild	
	74LS241	Fairchild	40
TTL-S	SN74S241	TI	
Octal Bus Driver			
TTL-LS	SN54LS244	† TI	
	SN74LS244	TI	
Hex Current Sensing Interface Gate			
TTL-LS	SN54LS63	† TI	
	SN74LS63	TI	
Microprogram Sequencer			
TTL-LS	AM2909C	AMD	
	AM2909M	† AMD	50
	AM2911C	AMD	
	AM2911M	† AMD	
Micro-Address Generator (for bit slice microprocessor)			
TTL-S	**SN54S482**	**† TI**	**(1099)**
	SN74S482	**TI**	**(1099)**

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—SPECIAL

Other Digital Devices

Function	Device	Source	Line
Analog to Digital Converter Logic (See also DVM Logic in this section)	MM5863	National	
Baud Rate Generator/Programmable Divider (ROM controlled divider)	MM5307	National	
	COM5016T	SMC	
	COM5016	SMC	
	BR1941	Western	10
Binary Rate Multiplier (supply 5v)	SP521B	Plessey	
Binary Sequence Generator, Psuedo Random (supply 5v)	SP540	Plessey	
Correlator (Continually compares two independently clocked serial inputs and gives correlation output)	64BCIV	TRW	
Custom Arrays (Digital and Linear circuits customized in final metalization)	XR-IIL-CHIP	Exar	20
	XR-CHIP	Exar	
	ULA	Ferranti	
	MONOCHIP	Interdesign	
	MASTERMOS	IMI	
	XC160	Motorola	
	XC177	Motorola	
	XC400	Motorola	
	ECL-ARRAY	Plessey	30
	ILL-ARRAY	Plessey	
	RTL-ARRAY	Plessey	
	CGA	TRW	
Calculators: See Linear-Consumer			
Counter, Gray Code (supply 5v)	SP520B	Plessey	
Counter, Decade, 1 GHz and above	MC1696	Motorola	
Counter, 4 Decade (Counts and stores, BCD Output, 0.5 MHz; supply -12,5v)	AY5-4057	GI	40
Counter/Display Decoder, 4 Decade (7 Segment and BCD outputs, 0.25 MHz; supply 5v)	MK5002	Mostek	
	MK5005	Mostek	
	MK5007	Mostek	
Counter, 5 Decade (includes storage, multiplexed BCD output, 0.6 MHz, supply -12,5v)	3815	Fairchild	50
Dual Counter (two 3-decade up/down counters with latch, BCD output. 0.5 MHz. 5-15 v)	LS7040	LSI Comp	
Counter/Display Driver, 1 Decade (7 segment output, 1 MHz; supply -13,-27v)	MEM1056	GI	
Counter/Display Driver. 1 Decade (7 segment and BCD output. 1 MHz ; supply -13,-27v)	MEM1056BCD	GI	60

Other Digital Devices (Cont'd)

Function	Device	Source	Line
Counter/Display Driver, 1 Decade Up/Down, (7 segment and BCD output, 0.5 MHz; supply -12,-27v)	MCS1003	† MOS	
Counter/Display Driver, 4 Decade Up/Down (7 segment output, 0.6 M Hz supply-12.5v; BCD; and serial output versions available)	AY5-4007	GI	70
	AY5-4007A	GI	
	AY5-4007D	GI	
Counter/Display Driver, 6 Decade Up/Down (7 segment and BCD output, 1 MHz, presettable compare register, latched output, LED drive maximum count 999999, 995959, or 595999 versions, supply 10-15 v)	MK50395	Mostek	
	MK50396	Mostek	
	MK50397	Mostek	80
	MK50398	Mostek	
	MK50399	Mostek	
Counter, 6 Decade, BCD output, 5 MHz, 8 latches (supply 5-15v)	LS7031	LSI Comp	
Counter, 8 Decade, BCD and 7 segment outputs, 5 MHz, latches (supply 5-15v)	LS7030	LSI Comp	
Counter/Display Driver, 7 Decade (7 segment output, supply 2-6v)	7208	Intersil	90
Counter Time-Base (Oscillator, programmable divider, 10^1 to 10^8, 2x10−7, 6x10−7, 6x10−8 and 36x10−8, supply -12,5v)	MK5009	Mostek	
Dual Counter/Timer	MM5865	National	
	DF215	**Siliconix (601)**	
Elapsed Time Counter (0.01 seconds to 1 hour, supply 2-5v)	7205	Intersil	100
Elapsed Time Counter (0.01 seconds to 24 hours, supply 2-5v)	7045	Intersil	
Programmable Diode Matrix, 5x5	HM-074	† Harris	
	HM-075	† Harris	
	HM-076	† Harris	
Programmable Diode Matrix, 5x8	HM-010	† Harris	110
	HM-012	† Harris	
	HM-013	† Harris	
Programmable Diode Matrix, 8x5	HM-080	† Harris	
	HM-081	† Harris	
	HM-084	† Harris	
Programmable Diode Matrix, 4x10	HM-090	† Harris	
	HM-091	† Harris	120
	HM-093	† Harris	
	HM-0110	Harris	
Programmable Diode Matrix,10x4	HM-050	† Harris	
(Continued)			

Other Digital Devices (Cont'd)

Function	Device	Source	Line
Programmable Diode Matrix,10x4 (Continued)	HM-051	† Harris	
	HM-055	† Harris	130
	HM-0104	Harris	
Programmable Diode Matrix,6x8	HM-030	† Harris	
	HM-031	† Harris	
	HM-034	† Harris	
	HM-0168	Harris	
Programmable Diode Matrix, 8x6	HM-040	† Harris	
	HM-041	† Harris	
	HM-044	† Harris	140
	HM-0186	Harris	
Programmable Diode Matrix, 10x16	S353	Siemens	
Divider, divide by 1/2, 1/525, supply -12v	MN115	Panasonic	
Divider, divide by 1/2, 1/625, supply -12v	MN116	Panasonic	
Programmable Divider (any modulo from 3 to 262,145, supply -12,5)	3816	Fairchild	150
Divider, divide by 2, 0.2 to 1 GHz	MC1690	Motorola	
	SP1690	Plessey	
	SP8602A	† Plessey	
	SP8602B	Plessey	
	SP8603A	† Plessey	
	SP8603B	Plessey	
	SP8604A	† Plessey	
	SP8604B	Plessey	
	SP8607A	† Plessey	160
	SP8607B	Plessey	
	SP8607M	Plessey	
Divider, divide by 4, 0.2 to 1 GHz	MC1697	Motorola	
	MC1699	Motorola	
	SP8600A	† Plessey	
	SP8600B	Plessey	
	SP8613B	Plessey	
	SP8614B	Plessey	
	SP8615B	Plessey	170
	SP8616D	Plessey	
Divider, divide by 4, above 1 GHz	11C05C	Fairchild	
	11C05M	† Fairchild	
	SP8616B	Plessey	
	SP8617	Plessey	
	SP8619	Plessey	
Divider, divide by 5, 0.2 to 1 GHz	SP8620A	† Plessey	
	SP8620B	Plessey	180
	SP8621B	Plessey	
	SP8622B	Plessey	
Divider, divide by 5/6, 0.2 to 1 GHz	11C91C	Fairchild	
	95H91C	Fairchild	
	SP8740A	† Plessey	
(Continued)			

† Military Temperature Range (−55°C to 125°C)

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DIGITAL—SPECIAL (Cont'd)

Other Digital Devices (Cont'd)

Function	Device	Source	Line
Divider, divide by 5/6, 0.2 to 1 GHz (Continued)			
	SP8740B	Plessey	
	SP8740M	Plessey	
	SP8745A	† Plessey	
	SP8745B	Plessey	
	SP8745M	Plessey	
Divider, divide by 6/7, 0.2 to 1 GHz			
	SP8741A	† Plessey	10
	SP8741B	Plessey	
	SP8741M	Plessey	
	SP8746A	† Plessey	
	SP8746B	Plessey	
	SP8746M	Plessey	
Divider, divide by 8, 0.25 to 1 GHz			
	SP8670	Plessey	
Divider, divide by 8, above 1 GHz			
	SP8676	Plessey	
	SP8677	Plessey	20
Divider, divide by 8/9, 0.25 to 1 GHz			
	SP8743B	Plessey	
	SP8743M	Plessey	
Divider, divide by 10, 0.2 to 1 GHz			
	SP8505	Plessey	
	SP8515	Plessey	
	SP8630B	Plessey	
	SP8631B	Plessey	
	SP8632B	Plessey	
	SP8634B	Plessey	30
	SP8635B	Plessey	
	SP8636B	Plessey	
	SP8637B	Plessey	
	SP8660A	† Plessey	
	SP8660B	Plessey	
Divider, divide by 10, above 1 GHz			
	MC1696	Motorola	
	SP8666	Plessey	
	SP8667	Plessey	
Divider, divide by 10/11, 0.2 to 1 GHz			40
	11C90C	Fairchild	
	95H90C	Fairchild	
	95H90M	† Fairchild	
	SP8640A	† Plessey	
	SP8640B	Plessey	
	SP8641A	† Plessey	
	SP8641B	Plessey	
	SP8642A	† Plessey	
	SP8642B	Plessey	
	SP8643B	Plessey	50
	SP8646A	† Plessey	
	SP8646B	Plessey	
	SP8646M	Plessey	
	SP8647A	† Plessey	
	SP8647B	Plessey	
	SP8647M	Plessey	
	SP8685A	† Plessey	
	SP8685B	Plessey	
	SP8690A	† Plessey	
	SP8690B	Plessey	60
	SP8695A	† Plessey	
	SP8695B	Plessey	

Other Digital Devices (Cont'd)

Function	Device	Source	Line
Divider, divide by 16, 0.2 to 1 GHz			
	SP8650B	Plessey	
	SP8651B	Plessey	
	SP8652B	Plessey	
	SP8659A	† Plessey	
	SP8659B	Plessey	
Divider, divide by 20, 0.2 to 1 GHz			70
	SP8657A	† Plessey	
	SP8657B	Plessey	
Divider, divide by 32, 0.2 to 1 GHz			
	SP8655A	† Plessey	
	SP8655B	Plessey	
Divider, divide by 64, 0.2 to 1 GHz			
	SP4020	Plessey	
Divider, divide by 64, above 1 GHz			
	SP8750	Plessey	
	SP8751	Plessey	80
	SP8752	Plessey	
Divider, divide by 256, above 1 GHz			
	SP8770	Plessey	
	SP8771	Plessey	
	SP8772	Plessey	
Divider Extender, divide by 4, to extend division ratios of two modulus counters while maintaining the difference (ie 5/6 to 20/21)			
	SP8790A	† Plessey	
	SP8790B	Plessey	90
	SP8790M	Plessey	
Divider Extender, divide by 8			
	SP8794A	† Plessey	
	SP8794B	Plessey	
	SP8794M	Plessey	
DVM Logic, 3-1/2 Decade (for dual ramp integration DVM BCD or 7 Segment Output; supply -15v)			
	AY5-3507	GI	
	AY5-3510	GI	100
DVM Logic 3-3/4 Digit (ramp integration, supply -7.5,-15)			
	AY5-3500	GI	
DVM Logic, 4 Digits (supply -17v)			
	MN6032	Panasonic	
DVM Logic, 4-1/2 Digit, (dual slope integration, supply -15,5)			
	MM5330	National	
DVM Logic, 4-1/2 Decade (Multiplexed BCD output; supply -12,5v)			110
	3814C	Fairchild	
DVM Logic, 4-3/4 Digit, (dual ramp integration, BCD and 7 segment output, supply 5v)			
	AY3-3550	GI	
Electronic Organ Circuits: See Linear-Consumer			
Flip-Flop, D-Type (750 MHz, ECL or TTL supplies)			
	11C06C	Fairchild	120
Flip-Flop, D-Type Master-Slave (ECL or TTL supplies)			
	11C70C	Fairchild	

Other Digital Devices (Cont'd)

Function	Device	Source	Line
Frequency Synthesizers: See Linear-Phase Locked Loop Circuits			
Frequency to Voltage: See Linear-Other Devices			
Dual AND/NAND Gate (supply 32-60v)			
	SP530A	Plessey	130
	SP530B	Plessey	
Dual OR Gate (supply 32-60v)			
	SP531A	Plessey	
	SP531B	Plessey	
Complex Latch, with persistance detector (supply 32-60v)			
	SP532A	Plessey	
	SP532B	Plessey	
Timing Element (supply 32-60v)			
	SP533A	Plessey	140
	SP533B	Plessey	
Gate, Dual OR/NOR (5/4-Input, 700ns delay, ECL or TTL supplies)			
	11C01C	Fairchild	
Hall Effect Switch (senses magnetic field)			
	DN830	Panasonic	
	DM831	Panasonic	
	DN834	Panasonic	
	DN835	Panasonic	
	DN837	Panasonic	150
	DN838	Panasonic	
	SAS211	Siemens	
	ULN-3006	Sprague	
	ULN-3008	Sprague	
	ULS-3006	Sprague	
Latch/Driver, 8-bit (supply ±-5,12v)			
	μPD754	NEC	
Multivibrator, astable (programmable pulse width, current controlled pulse rep. rate, supply 3-7v)			160
	MC3380	Motorola	
Pulse Group Encoder (2141) and Decoder (2151) for pulse width code systems (2^5 codes programmed by RC networks)			
	TMX2141	TMX	
	TMX2151	TMX	
Regulators, Switching: See Linear-Other Devices			
Schmitt Trigger, Complementary Open Collector Output; supply 2.2 to 6v			170
	ULN-3303	Sprague	
Schmitt Trigger, Programmable			
	CA3098	† RCA	
	CA3099	† RCA	
Schmitt Trigger, Zener Clamped Output; supply 2.2 to 6v			
	MCC102	Micro Comp	
	ULN-3304	Sprague	
Schmitt Trigger, Dual, Complementary Open Collector Outputs; supply 2.2 to 6v			180
	MCC122	Micro Comp	
	ULN-3305	Sprague	
Schmitt Trigger, Dual one Open Collector Output, one Zener Clamped Output; supply 2.2 to 6v			
	ULN-3306	Sprague	

† Military Temperature Range (−55°C to 125°C)

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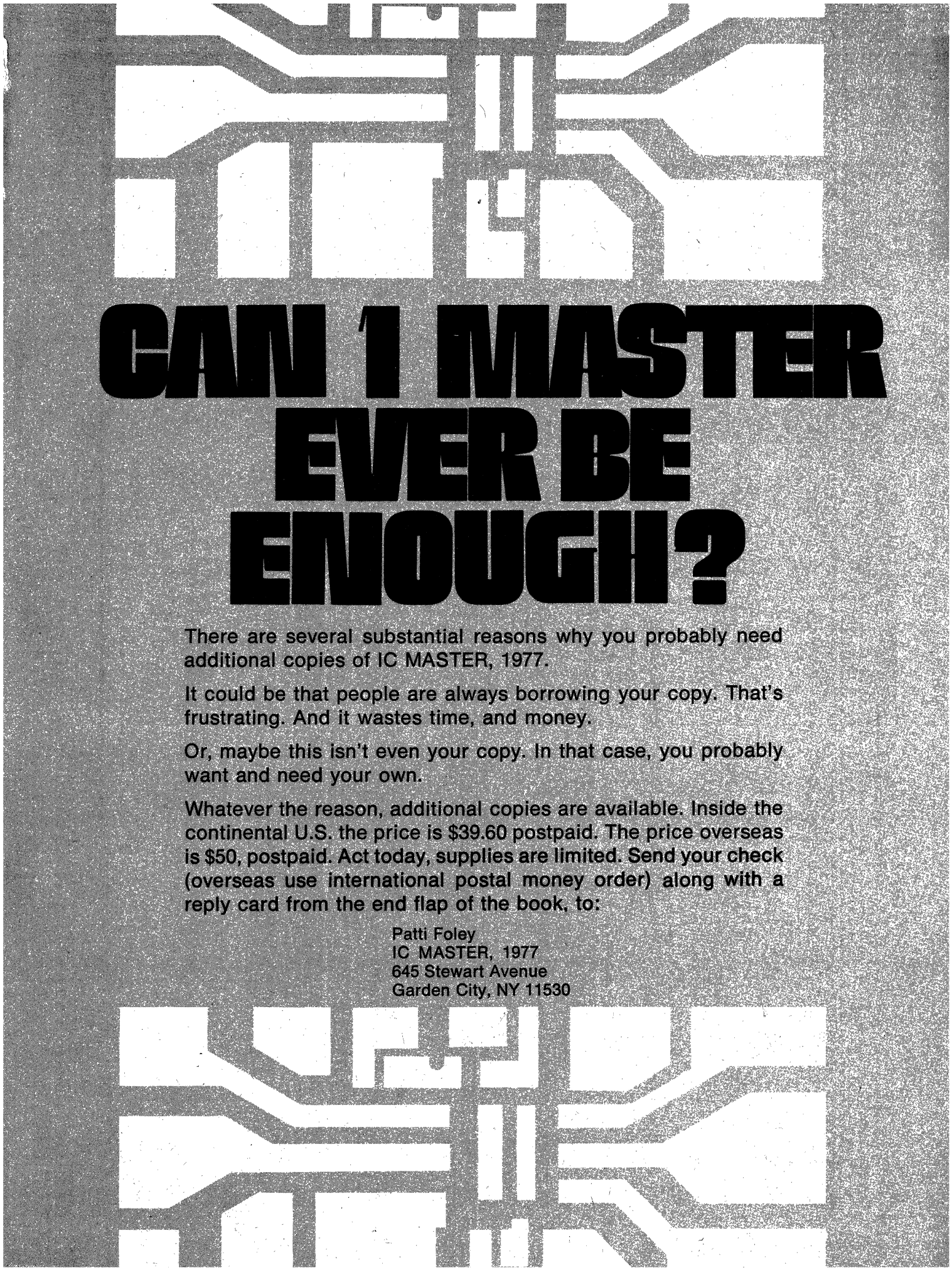
DIGITAL—SPECIAL (Cont'd)

Function	Device	Source	Line
Other Digital Devices (Cont'd)			
Schmitt Trigger, Dual, Low voltage; 3.5v	SN76811	TI	
Timers: See Linear-Timers			
T.V. Camera Sync. Generator; supply -12,5v	3262A	Fairchild	
	3262B	Fairchild	
	MM4320	National	
	MM5320	† National	
T.V. Camera Sync. Generator; supply -15,-21v	MN6060	Panasonic	10
T.V. Camera Sync. Generator; supply 5v	ZNA103E	Ferranti	
T.V. Color Bar Generator	MM5322	National	
Voltage to Frequency: See Linear-Other Devices			
Watch Circuits-See Linear-Consumer Circuits			

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.



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Consumer Circuits

Series	Description	Digits	Power Supply (V)	Process	Packaging	
					Die	DIP (1T)
Watch Circuits						
S1408	Two-function LCD Watch/Clock (Hrs/Min)	3½	+1.5	CMOS	S1409	S1408
S1424A	Five-function LCD Watch (Hrs/Min or See or Month/Date with alternating time/date mode and voltage tripler display options)	3½	+1.5	CMOS	S1424A	S1427A
S11011	Six-function LCD plus alarm/chronometer/ alternate time zone options	4	+1.5	CMOS	S11011	S11012

Part No.	Description	Power Supply (V)	I/O	Power Dis. (mW)	Process	Package
Clock and DVM Circuits						
S1856	LED/Gas D. Auto Clock (3½ digits)	+6 to +16	MOS	70	P-I^2	1T
S1998A	50/60 Hz Line Clock (4 digits)-LED	+8 to +26	MOS	300	P-I^2	1T
S1998B	50/60 Hz Line Clk.–Gas Discharge	+8 to +33	MOS	300	P-I^2	1T
S1998C	50/60 Hz Line Clk.–Fluorescent	+8 to +26	MOS	300	P-I^2	1T
Organ Circuits						
S2193	7 Stage Frequency Divider	-14, -28	MOS	300	P-I^2	1D
S10129/30/31	6 Stage Frequency Divider(1)	-14, -27	MOS	350	P-I^2	1D
S2555	7 Out Frequency Synthesizer	-15, -27	MOS	400	HI V_T	1D
S2556	6 Out Frequency Synthesizer	-15, -27	MOS	400	HI V_T	1D
S2566	Rhythm ROM	-15, -27	MOS	300	HI V_T	1W
S2567	Rhythm Counter	-15, -27	MOS	400	HI V_T	1D
S50240/41/42	Top Octave Synthesizer	-11, -16	MOS	360	P-I^2	1U
S8890	Rhythm Generator	-12	MOS	400	P-I^2	1T
S9660	Rhythm Generator(2)	-12	MOS	400	P-I^2	1Z

(1) Optional 7-stage divider, with different pinout, is available

(2) Various pinouts available

Liquid Crystal Displays for Watches/Clocks/Instruments

Device No.	Description	Application	Compatible Circuit
D8130A Series (formerly S23570)	A 3½-digit, 3-Volt display suitable for use in men's watches. Special-order options available: • Thinner glass version • Custom artwork	Watch	S1408 S1424A
D8135A Series (formerly S23590)	A 3½-digit, 3-Volt display suitable for use in men's watches. Special-order options available: • Thinner glass version • Custom artwork	Watch	S1408-9 S1424A S1426A
D8137A Series (formerly S23610)	A 5½-digit, 3-Volt display suitable for use in men's watches. Special-order options available: • Thinner glass version • Custom artwork	Watch	
D8141A Series (formerly S23620)	A 5½-digit, 3-Volt display with "date" and "Sec" annunciators, suitable for use in men's watches. Special order options available: • Thinner glass version • Custom artwork	Watch	Nortec 5022 Micropower MPS7125
D8143A Series	A *proposed* ladies 3½-digit watch display.	Watch	
D8145A Series (formerly S23652)	A very popular glass size for 3½-digit watch display. The glass size is the prime industry standard, and will be used for several new digit configurations. Special order options available: • Thinner glass version • Custom artwork	Watch	S1408 S1424A
D8151A Series	A 3½-digit display with extremely large digits in a popular-sized display package. Special order option available: • Custom artwork	Watch	S1408 S1424A
D8154A Series	A 4-digit alphanumeric watch display with annunciators in a very popular glass size, destined to become an industry standard. Special order option available: • Custom artwork	Watch	AMI S11011 Intersil 7210
D8160A Series	A *proposed* "Uni-Sex" sized display that could be used in either a man's or ladies' watch.	Watch	S1408 S1424A
D8300A Series	A 5½-digit clock display with "date" and "Sec" annunciators, packaged in a popular glass size, with a primary digit height of 0.7 in.	Clock	Nortec 5022 Micropower MPS7125
D8301A Series	A 3½-digit combination clock/instrument display, packaged in a popular glass size, with a digit height of 0.5 in.	Clock/ Instrument	S1408, S1424A
D8302A Series	A 3½-digit clock display with "AM/PM" annunciators, packaged in a popular glass size, with a digit height of 1.1 in.	Clock	S1408 S1424A

Complete Data Sheets on all Standard Products Available from Your Local AMI Sales Office Listed Inside the Front Cover

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HARRIS SEMICONDUCTOR
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HARRIS is BIG in CMOS

All three major series...54C/74C, 4000, and 14500

Harris now offers commercial devices in both CERDIP and Epoxy 410-B, rated for -40°C to +85°C. And high-rel versions—CERDIP and Flat-Pack for -55°C to +125°C. All devices available in chip form as well.

FUNCTIONAL INDEX

DESCRIPTION	DEVICE NO.
ARITHMETIC FUNCTIONS	
4-Bit Full Adder	HD-4008B
4-Bit Binary Full Adder	HD-74C83
4-Bit Magnitude Comparator	HD-14585B
COUNTERS	
Decade Counter/Divider	HD-4017B
Presettable Divide-by-"N" Counter	HD-4018B
14-Stage Binary/Ripple Counter	HD-4020B
Divide-by-8 Counter/Divider with 8 Decoded Outputs	HD-4022B
7-Stage Binary/Ripple Counter	HD-4024B
Presettable Up/Down Counter	HD-4029B
12-Bit Binary Counter	HD-4040B
Synchronous Decade	HD-74C160
Synchronous Binary	HD-74C161
Fully Synchronous Decade	HD-74C162
Synchronous Up/Down Decade	HD-74C192
Synchronous Up/Down Binary	HD-74C193
4-Bit Counter/7 Segment Output	HD-74C925
BCD Up/Down Counter	HD-14510B
Binary Up/Down Counter	HD-14516B
Dual BCD Up Counter	HD-14518B
Dual Binary Up Counter	HD-14520B
Decade Counter	HD-74C90
4-Bit Binary Counter	HD-74C93
Full Sync Binary Counter	HD-74C163
4 Decade Counter Divider	HD-74C925
4 Decade Counter Divider with Display Select	HD-74C926
Minutes and Seconds Counter Divider	HD-74C927
3½ Decade Counter Divider	HD-74C928
Programmable BCD Divide-by-N Counter	HD-14522B
Programmable BCD Binary Divide-by-N Counter	HD-14526B
GATES/BUFFERS	
Dual 3-Input NOR Gate	HD-4000UB
Quad 2-Input NOR Gate	HD-4001B
Dual 4-Input NOR Gate	HD-4002B
Dual Complementary Pair with Inverter	HD-4007B
Quad 2-Input NAND Gate	HD-4011B
Dual 4-Input NAND Gate	HD-4012B
Quad AND/OR Select	HD-4019B
Triple 3-Input NAND	HD-4023B
Triple 3-Input NOR	HD-4025B
Quad 2-Input Exclusive OR	HD-4030B
Hex Buffer/Converter, Inverting	HD-4049UB
Hex Buffer/Converter, Non-Inverting	HD-4050B
Hex Inverter	HD-4069UB
Quad Exclusive-OR Gate	HD-4070B
Quad 2-Input AND Gate	HD-4081B
Quad 2-Input NAND	HD-74C00
Quad 2-Input NOR	HD-74C02
Hex Inverter	HD-74C04
Quad 2-Input AND	HD-74C08
Triple 3-Input AND	HD-74C10
Dual 4-Input NAND	HD-74C20
8-Input NAND	HD-74C30
Quad 2-Input OR	HD-74C32
Quad 2-Input Exclusive OR	HD-74C86
Three State Hex Buffer	HD-80C95
Three State Hex Buffer	HD-80C97
Hex Buffer/Converter, Inverting	HD-74C901
Hex Buffer/Converter, Non-Inverting	HD-74C902
Hex Inverting PMOS Buffer	HD-74C903
Hex Buffer (MOS Interface)	HD-74C904
Hex Open Drain N-Channel Buffer	HD-74C906
Hex Open Drain P-Channel Buffer	HD-74C907
Hex 3-State Buffer	HD-14503B
4-Bit AND/OR Selector	HD-14519B
DECODERS MULTIPLEXERS	
BCD to Decimal Decoder	HD-4028B
Single 8-Channel Multiplexer	HD-4051B
Differential 4-Channel Multiplexer	HD-4052B
Triple 2-Channel Multiplexer	HD-4053B
Quad Bilateral Switch	HD-4066B
BCD to Decimal Decoder	HD-74C42
BCD to 7-Segment Decoder	HD-74C48
8-Channel Digital Multiplexer	HD-74C151
4-Line to 16-Line Decoder/Demultiplexer	HD-74C154
Quad 2-Input Multiplexer	HD-74C157
8-Channel Data Selector	HD-14512B
4-Bit Latch/4 to 16-Line Decoder	HD-14514B
4-Bit Latch/4 to 16-Line Decoder	HD-14515B
Dual 4-Channel Analog Data Selector	HD-14529B
BCD to 7-Segment Latch/Decoder/Driver	HD-14543B
BCD to 7-Segment Decoder	HD-14558B
FLIP FLOPS	
Dual "D" with Set/Reset	HD-4013B
Dual J-K with Set/Reset	HD-4027B
Quad Clocked "D" Latch	HD-4042B
Quad Three State NOR Reset/Set Latch	HD-4043B
Quad Three State NAND Reset/Set Latch	HD-4044B
Dual "J-K" Master/Slave	HD-74C73
Dual "D" with Set/Reset	HD-74C74
Dual "J-K" Master/Slave Preset	HD-74C76
Dual "J-K"	HD-74C107
Quad "D" Three States (Quad Latch)	HD-74C173
Hex "D"	HD-74C174
Quad "D"	HD-74C175
SHIFT REGISTERS	
18-Stage Static	HD-4006B
8 Stage Synchronous Parallel Input/Serial Output	HD-4014B
Dual 4 Stage with Serial Input/Parallel Output	HD-4015B
8 Stage Asynchronous Parallel Input/Serial Output	HD-4021B
4 Stage with J-K Input and True/Complement Output	HD-4035B
4-Bit Right-Shift Left-Shift	HD-74C95
8-Bit Serial-In Parallel Out	HD-74C164
8 Stage Synchronous Parallel Input/Serial Output	HD-74C165
4-Bit Parallel-In Parallel-Out	HD-74C195
SPECIAL FUNCTION	
Hex Schmitt Trigger	HD-74C14
64-Bit RAM	HD-74C89
256-Bit Three State RAM	HD-74C200
Dual Monostable Multivibrator	HD-74C221
Hex Schmitt Trigger	HD-74C914
16-Key Keyboard Encoder	HD-74C922
20-Key Keyboard Encoder	HD-74C923
BCD to 7-Segment Latch/Decoder/Driver	HD-14511B
BCD Rate Multiplier	HD-14527B
Dual One Shot	HD-14528B
Hex Schmitt Trigger	HD-14584B

All Listed 74C Devices are also Available as 54C.
All Listed 80C Devices are also Available as 70C.

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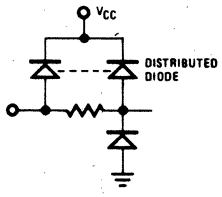
Family Features

These circuits employ complementary MOS (CMOS) to achieve low power dissipation, high noise immunity and wide power supply voltage ranges with symmetric rise and fall times. Features such as these make the 4000 and 54C/74C families ideal for use in digital systems.

The 4000 series is popular because of the wide range of logic functions and readily abundant supply.

The 54C/74C series is ideal for "worse case" noise immunity design. Function and pin out compatibility with 54/74 TTL devices minimizes design time for those designers already familiar with that logic family.

- **Wide Supply Voltage Range** 3.0V to 15V
- **Guaranteed Noise Margin** 1.0V
- **High Noise Immunity** 0.45 V_{CC} Typ.
- **Low Power** 10nW Typ. for Gates
  10 µW Typ. for MSI Circuits
- **All inputs are protected from damage due to static discharge by diode clamps to V_{CC} and GND unless otherwise noted.**



CMOS Product Code

Harris CMOS Products are designated by "PRODUCT CODE". When ordering, please refer to products by the full code. Harris Products will always begin with "H". Specific device numbers will always be isolated by hyphens.

4000 SERIES

EXAMPLE: H D 1 - 4001A 2

- H – HARRIS LOGO (LETTER – H)
- D – FAMILY DESIGNATION (LETTERS)
- 1 – PACKAGE TYPE (NUMBERS)
- 4001A – SPECIFIC DEVICE TYPE NUMBERS & LETTERS
- 2 – TEMPERATURE RANGE (NUMBERS)

FAMILY (LETTERS)	PACKAGE (NUMBERS)	TEMPERATURE RANGE
D – DIGITAL	1 – DUAL IN-LINE CERAMIC	2 – -55°C to +125°C
	9 – FLAT PACKAGE	9 – -40°C to +85°C

54C/74C SERIES

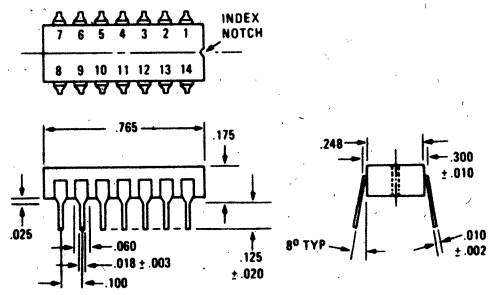
EXAMPLE: H D 9 - 74C10

- H – HARRIS LOGO (LETTER – H)
- D – FAMILY DESIGNATION (LETTERS)
- 9 – PACKAGE TYPE (NUMBERS)
- 74C – TEMPERATURE RANGE (NUMBERS)
- 10 – SPECIFIC DEVICE TYPE NUMBERS

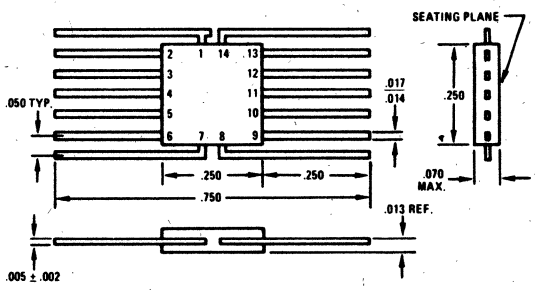
FAMILY (LETTERS)	PACKAGE (NUMBERS)	TEMPERATURE RANGE
D – DIGITAL	1 – DUAL IN-LINE CERAMIC	54C – -55°C to +125°C
	9 – FLAT PACKAGE	74C – 0°C to +70°C

Packaging Code

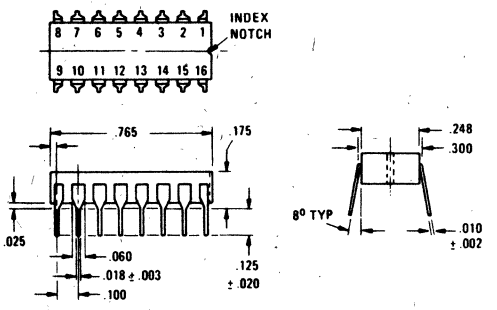
Code 1U 14 LEAD CERAMIC D.I.P. (CERDIP) *



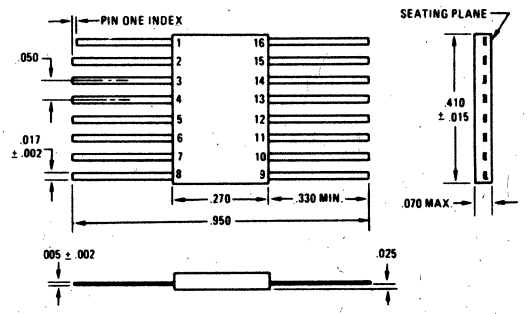
Code 9V TO-86 (METAL BOTTOM) BRAZED SEAL FLAT PACK *



Code 1W 16 LEAD CERAMIC D.I.P. (CERDIP) *



Code 9L 16 LEAD BRAZED SEAL FLAT PACK *



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9LS
25LS
54LS
74LS

Total Low-Power Schottky from Raytheon

Raytheon offers the full family of low-power Schottky devices: The new military standard 9LS, the high-performance 25LS, the old military standard 54LS and the industrial/commercial standard 74LS devices.

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RAYTHEON
SEMICONDUCTOR DIVISION

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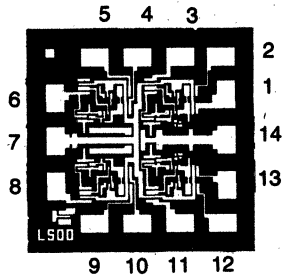
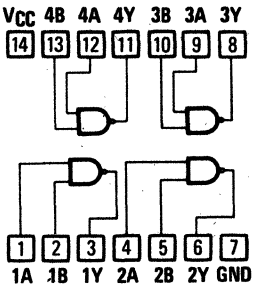
Positive-NAND Gates, Hex Inverters

LS00 LS04
LS10 LS20 LS30

PIN-OUT AND LOGIC DIAGRAMS

LS00
QUADRUPLE 2-INPUT NAND GATE

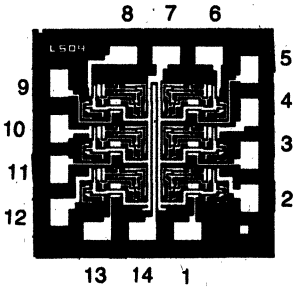


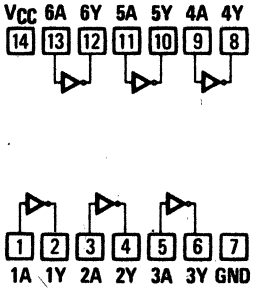


Positive logic: $Y = \overline{AB}$

Die Size .047 x .048

LS04
HEX INVERTER

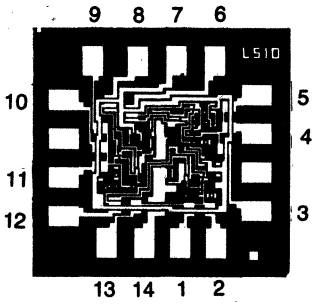


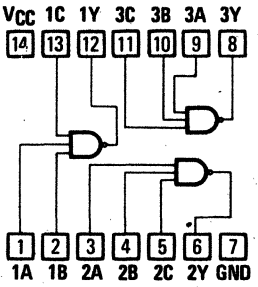


positive logic: $Y = \overline{A}$

Die Size .048 x .051

LS10
TRIPLE 3-INPUT NAND GATE

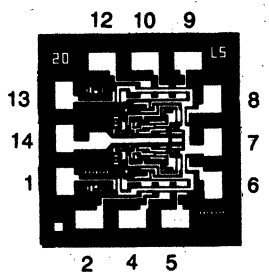


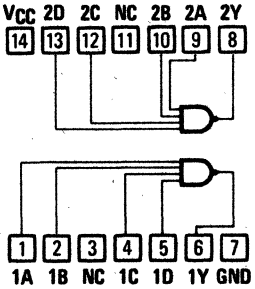


positive logic: $Y = \overline{ABC}$

Die Size .052 x .054

LS20
DUAL 4-INPUT NAND GATE



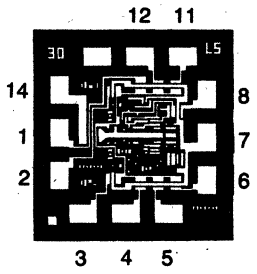


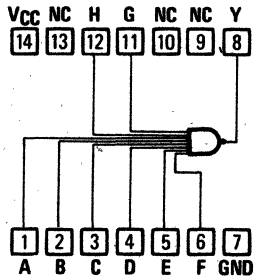
positive logic: $Y = \overline{ABCD}$

Die Size .042 x .044

NC — No internal connection

LS30
8-INPUT NAND GATE





positive logic: $Y = \overline{ABCDEFGH}$

Die Size .042 x .044

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Positive-NAND Gates, Hex Inverters

Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
Normalized fan-out from each output, N	High logic level			20			20	
	Low logic level			10			20	
Operating free-air temperature, T_A		-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IL}=V_{IL}max, I_{OH}=-400μA, V_{IL}=0.7V		2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V	I_{OL}=4 mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8 mA					0.3	0.45	V
I_I	V_{CC}=MAX, V_I=7.0V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.36			-0.36	mA
I_{OS}	V_{CC}=MAX,		-15		-100	-15		-100	mA
I_{CCH}	V_{CC}=MAX, All inputs at 0V	LS00,04,10,20		0.2	0.4		0.2	0.4	mA
		LS30		0.35	0.5		0.35	0.5	
I_{CCL}	V_{CC}=MAX, All inputs at 4.5 V			0.6	1.1		0.6	1.1	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter		−55°C			+25°C			+125°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A, page 2-147)											
t_{PLH}	LS00,04, 10,20		6	12	3.0	5.0	10		7	12	ns
	LS30		7	11	4.0	6	11		9	15	
t_{PHL}	LS00,04,10,		9	15	3.0	5.0	10		8	14	ns
	LS20		10	16	4.0	8.0	12		10	16	
	LS30		18	25	6.0	15	20		10	17	
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. A, page 2-147)											
t_{PLH}	LS00,04, 10,20		9	15		9	15		10	16	ns
	LS30		8	13		8	13		12	18	
t_{PHL}	LS00,04,10,		11	17		10	16		10	16	ns
	LS20		12	16		12	16		12	18	
	LS30		27	35		21	28		16	23	

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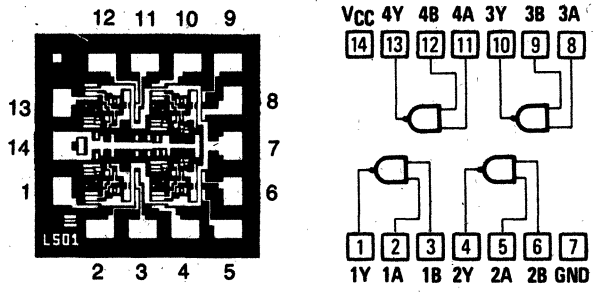
Positive-NAND Gates, Hex Inverters With Open-Collector Outputs

LS01 LS03 LS05 LS12 LS22

PIN-OUT AND LOGIC DIAGRAMS

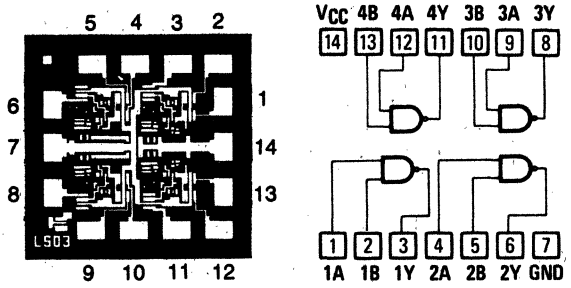
LS01
QUADRUPLE 2-INPUT NAND GATE



positive logic: $Y = \overline{AB}$

Die Size .047 x .048

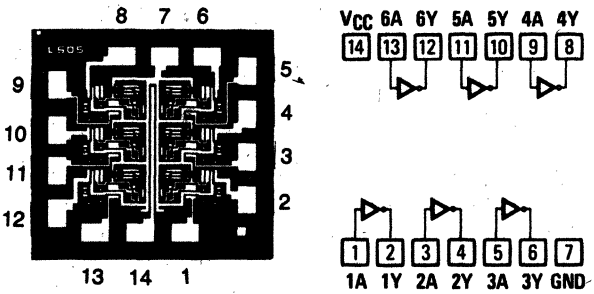
LS03
QUADRUPLE 2-INPUT NAND GATE



positive logic: $Y = \overline{AB}$

Die Size .047 x .048

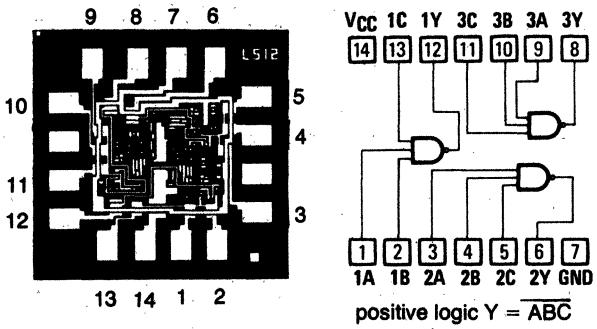
LS05
HEX INVERTER



positive logic: $Y = \overline{A}$

Die Size .048 x .051

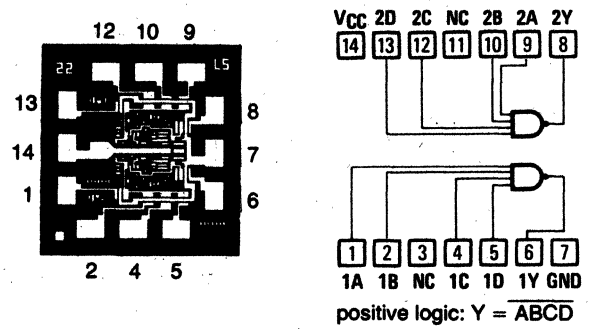
LS12
TRIPLE 3-INPUT NAND GATE



positive logic $Y = \overline{ABC}$

Die Size .052 x .054

LS22
DUAL 4-INPUT NAND GATE



positive logic: $Y = \overline{ABCD}$

Die Size .042 x .044

NC–No internal connection

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Positive-NAND Gates, Hex Inverters With Open-Collector Outputs

Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC} (See Note 1)	4.5	5	5.5	4.75	5	5.25	V
High-level output voltage, V_{OH}			5.5			5.5	V
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	−55		125			70	°C

NOTE 1: Voltage values are with respect to network ground terminal.

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*			9LS/54LS			9LS/74LS			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I	V_{CC}=MIN,	I_I=−18mA				−1.5			−1.5	V
I_{OH}	V_{CC}=MIN,	V_{OH}=5.5V	V_{IL}=0.7V			100			100	μA
V_{OL}	V_{CC}=MIN,	V_{IH}=2V	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
			I_{OL}=8mA					0.3	0.5	
I_I	V_{CC}=MAX,	V_I=7.0V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX,	V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX,	V_I=0.4V				−0.36			−0.36	mA
I_{CCH}	V_{CC}=MAX,	All inputs at 0V			0.2	0.4		0.2	0.4	mA
I_{CCL}	V_{CC}=MAX,	All inputs at 4.5V			0.6	1.1		0.6	1.1	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	−55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Figure B, page 2-147)										
t_{PLH}				7.0	14	22				ns
t_{PHL}				4.0	10	18				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Figure B, page 2-147)										
t_{PLH}										ns
t_{PHL}										ns

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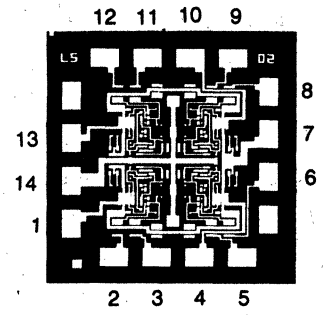
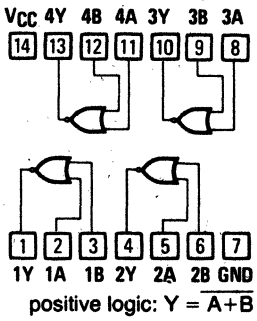
Positive-NOR Gates

LS02 LS27

PIN-OUT AND LOGIC DIAGRAMS

LS02
QUADRUPLE 2-INPUT NOR GATE

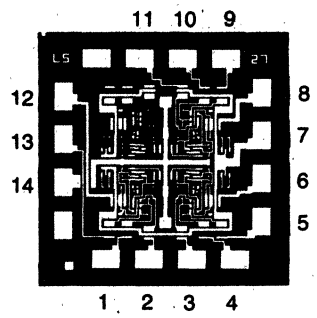


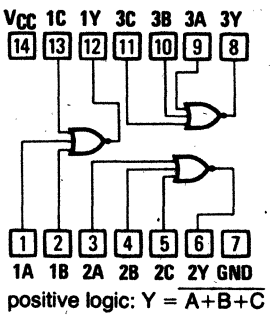


positive logic: $Y = \overline{A+B}$

Die Size .053 x .053

LS27
TRIPLE 3-INPUT NOR GATE





positive logic: $Y = \overline{A+B+C}$

Die Size .053 x .053

Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
Normalized fan-out from each output, N	High logic level			20			20	
	Low logic level			10			20	
Operating free-air temperature, T_A		-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, I_{OH}=-400μA	V_{IL}=0.7V	2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN,	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.36			-0.36	mA
I_{OS}	V_{CC}=MAX,		-15		-100	-15		-100	mA
I_{CCH}†	V_{CC}=MAX, All inputs at 0V	LS02		1.6	3.2		1.6	3.2	mA
		LS27		2.0	4.0		2.0	4.0	
I_{CCL}	V_{CC}=MAX, All inputs at 5V	LS02		2.8	5.4		2.8	5.4	mA
		LS027		3.4	6.8		3.4	6.8	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

Switching Characteristics, V_{cc} = 5V Over Recommended Free-Air Temperature Range

Parameter	-55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A, page 2-147)										
t_{PLH}				3.0	6.0	10				ns
t_{PHL}				3.0	5.0	10				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. A, page 2-147)										
t_{PLH}										ns
t_{PHL}										ns

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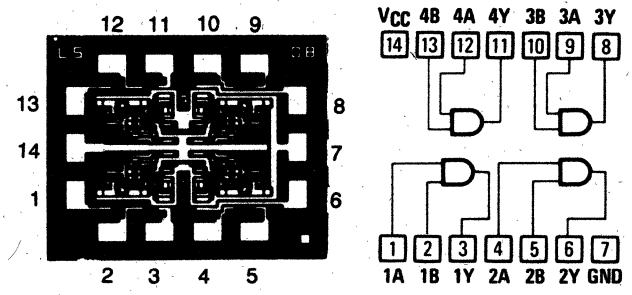
PIN-OUT AND LOGIC DIAGRAMS

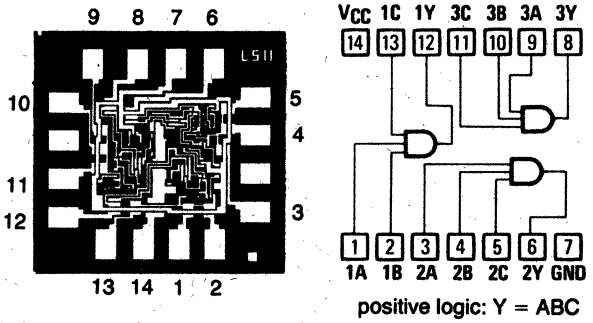
LS08
QUADRUPLE 2-INPUT AND GATES



positive logic: Y = AB

Die Size .045 x .056

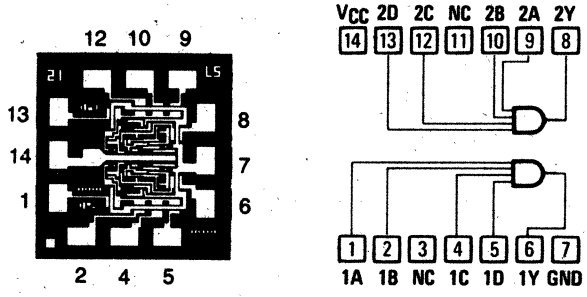
LS11
TRIPLE 3-INPUT AND GATES



positive logic: Y = ABC

Die Size .052 x .054

LS21
DUAL 4-INPUT AND GATES



positive logic: Y = ABCD

Die Size .042 x .044

NC–No internal connection

Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
Normalized fan-out from each output, N	High logic level			20			20	
	Low logic level			11			20	
Operating free-air temperature, T_A		−55		125	0		70	°C

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Positive-AND Gates

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=−18mA				−1.5			−1.5	V
V_{OH}	V_{CC}=MIN, I_{OH}=−400μA	V_{IH}=2.0V	2.5	3.4		2.7	3.4		V
V_{OL}		I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
I_I	V_{CC}=MAX, V_I=7.0V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				−0.36			−0.36	mA
I_{OS}	V_{CC}=MAX		−15		−100	−15		−100	mA
I_{CCH}	V_{CC}=MAX, All inputs at 4.5V			0.6	1.2		0.6	1.2	mA
I_{CCL}	V_{CC}=MAX, All inputs at 0V			1.1	2.2		1.1	2.2	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter		−55°C			+25°C			+125°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A, page 2-147)											
t_{PLH}	LS08,11		9	4		8.5	13		9	14	ns
	LS21		10	15		9	14		10	15	
t_{PHL}	LS08,11		6	11		6	10		8	12	ns
	LS21		6	11		6	10		8	12	
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. A, page 2-147)											
t_{PLH}	LS08,11		11	17		10	15		11	16	ns
	LS21		12	18		11	16		12	17	
t_{PHL}	LS08,11		10	15		8	12		11	16	ns
	LS21		10	15		8	12		11	16	

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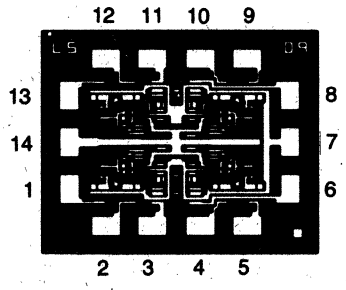
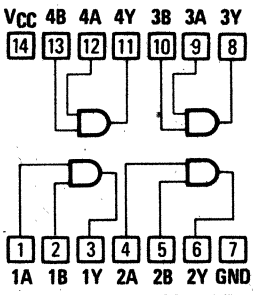
Positive-AND Gates With Open-Collector Outputs

PIN-OUT AND LOGIC DIAGRAMS

LS09
QUADRUPLE 2-INPUT AND GATES

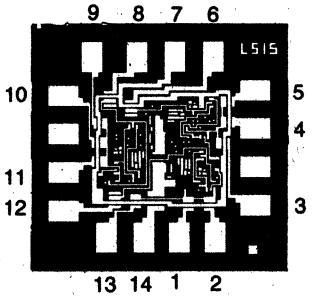


Die Size .045 x .056

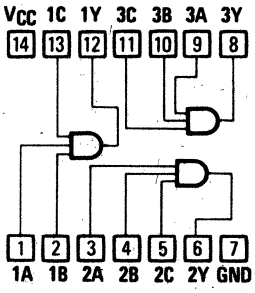


positive logic: Y = AB

LS15
TRIPLE 3-INPUT AND GATES



Die Size .052 x .054



positive logic: Y = ABC

Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC} (See Note 1)	4.5	5	5.5	4.75	5	5.25	V
High-level output voltage, V_{OH}			5.5			5.5	V
Low-level output current, I_{OL}	-55		125	0		70	°C

NOTE 1: Voltage values are with respect to network ground terminal.

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{OH}=5.5V,	V_{IH}=2.0V			100			100	μA
I_{OH}	V_{CC}=MIN, V_{IL}=V_{IL}MAX	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
I_I	V_{CC}=MAX, V_I=7.0V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.36			-0.36	mA
I_{CCH}	V_{CC}=MAX, All inputs at 4.5V			0.6	1.2		0.6	1.2	mA
I_{CCL}	V_{CC}=MAX, All inputs at 0V			1.1	2.2		1.1	2.2	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	-55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ										
t_{PLH}		14	20		14	21		28	42	ns
t_{PHL}		10	15		8	12		9	13	ns
Test Conditions: C_L = 50pF, R_L = 2kΩ										
t_{PLH}		30	38		30	38		40	54	ns
t_{PHL}		16	23		12	17		13	17	ns

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Schmitt-Trigger Positive-NAND Gates and Inverters with Totem-Pole Outputs

LS13 LS14

FEATURES

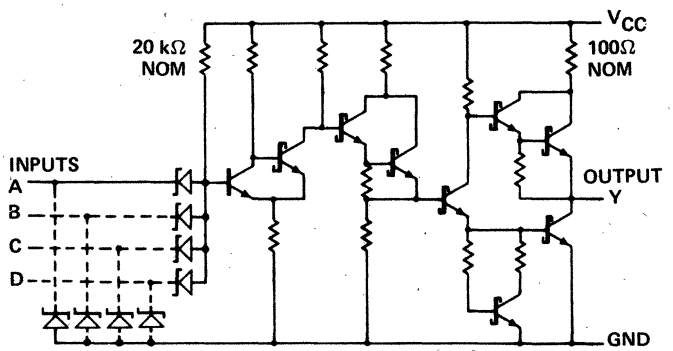
- Operation from Very Slow Transitions
- Temperature-Compensated Threshold Levels
- Temperature-Compensated Hysteresis, Typically 0.8V
- High Noise Immunity

DESCRIPTION

Each circuit functions as a NAND gate or inverter, but because of the Schmitt action, it has different input threshold levels for positive- and negative-going signals. The hysteresis or backlash, which is the difference between the two threshold levels, is typically 800 millivolts.

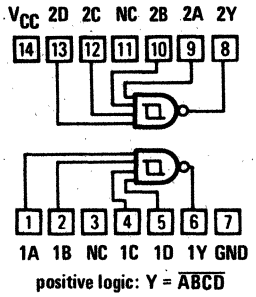
These circuits are temperature compensated and can be triggered from the slowest of input ramps and still give clean, jitter-free output signals.

SCHEMATIC (EACH GATE)



PIN-OUT AND LOGIC DIAGRAMS

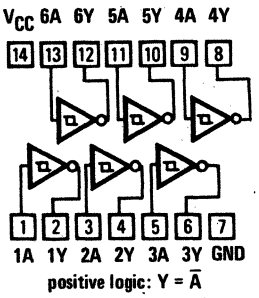
LS13



positive logic: $Y = \overline{ABCD}$

NC- No internal connection

LS14



positive logic: $Y = \overline{A}$

Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-400			-400	μA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

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Schmitt-Trigger Positive-NAND Gates and Inverters with Totem-Pole Outputs

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

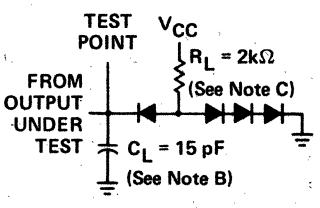
Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{T+}	V_{CC}=5V		1.5	1.7	2	1.5	1.7	2	V
V_{T-}	V_{CC}=5V		0.6	0.9	1.1	0.6	0.9	1.1	V
$V_{T+} - V_{T-}$	V_{CC}=5V		0.4	0.8		0.4	0.8		V
V_I	V_{CC}=MIN, I_I=−18mA				−1.5			−1.5	V
V_{OH}	V_{CC}=MIN, I_{OH}=−400μA, V_I=0.6V		2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_I=2V	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
I_{T+}	V_{CC}=5V, V_I=V_{T+}			−0.14			−0.14		mA
I_{T-}	V_{CC}=5V, V_I=V_{T-}			−0.18			−0.18		mA
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				−0.4			−0.4	mA
I_{OS}	V_{CC}=MAX		−6		−40	−5		−42	mA
I_{CCH}	V_{CC}=MAX, V_I=0V	LS13		2.9	6		2.9	6	mA
		LS14		8.6	16		8.6	16	
I_{CCL}	V_{CC}=MAX, V_I=4.5V	LS13		4.1	7		4.1	7	mA
		LS14		12	21		12	21	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

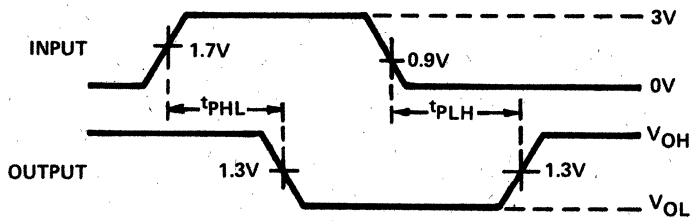
Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter		−55°C			+25°C			+125°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ											
t_{PLH}	LS13					15	22				ns
	LS14					15	22				ns
t_{PHL}	LS13					18	27				ns
	LS14					15	22				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ											
t_{PLH}	LS13										ns
	LS14										ns
t_{PHL}	LS13										ns
	LS14										ns

PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT



VOLTAGE WAVEFORMS

NOTES: A. The input waveform is supplied by a generator with the following characteristics: Z_{out} = 50Ω and PRR ≤ 1 MHz, t_r ≤ 15 ns, t_f ≤ 6 ns.
B. C_L includes probe and jig capacitance.
C. All diodes are 1N916 or 1N3064.

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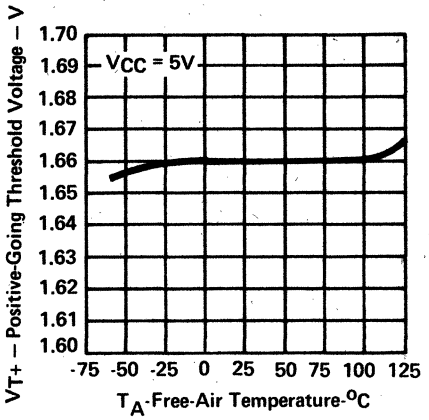
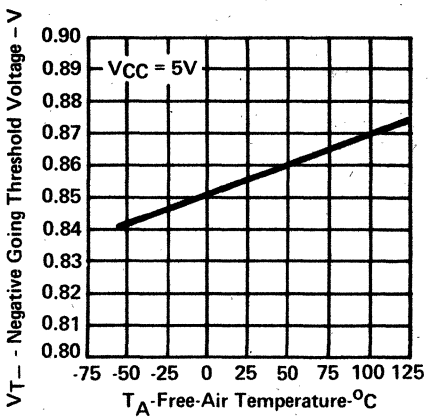
Schmitt-Trigger Positive-NAND Gates and Inverters with Totem-Pole Outputs

TYPICAL CHARACTERISTICS†

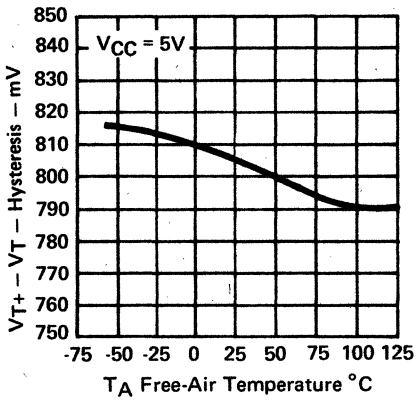
POSITIVE-GOING THRESHOLD VOLTAGE VS FREE-AIR TEMPERATURE



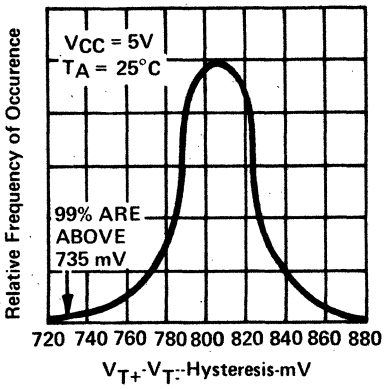
NEGATIVE-GOING THRESHOLD VOLTAGE VS FREE-AIR TEMPERATURE



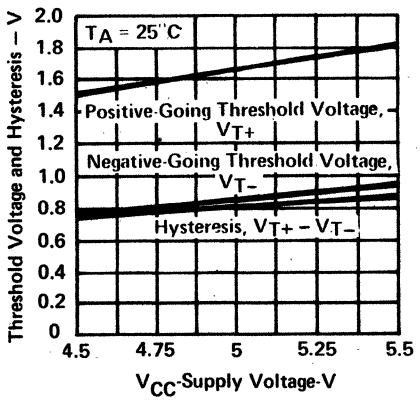
HYSTERESIS VS FREE-AIR TEMPERATURE



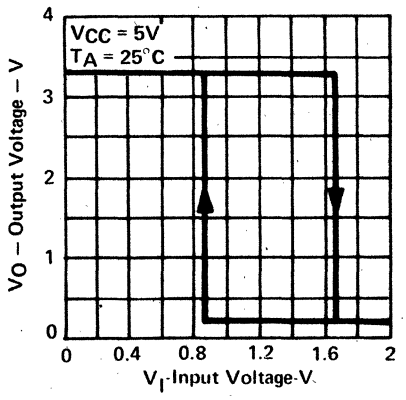
DISTRIBUTION OF UNITS FOR HYSTERESIS



THRESHOLD VOLTAGES AND HYSTERESIS VS SUPPLY VOLTAGE



OUTPUT VOLTAGE VS INPUT VOLTAGE



†Data for temperatures below 0°C and above 70°C and supply voltages below 4.75V and above 5.25 are applicable for 9LS/54LS13, and 9LS/54LS14.

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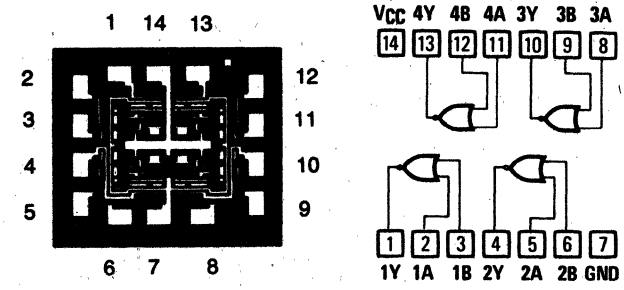
PIN-OUT AND LOGIC DIAGRAMS

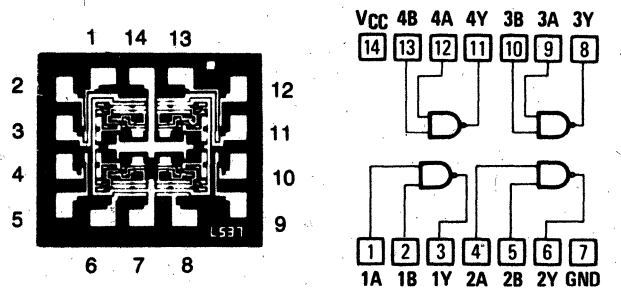
LS28
QUADRUPLE 2-INPUT NOR BUFFER



Die Size .045 x .052

positive logic: $Y = \overline{A+B}$

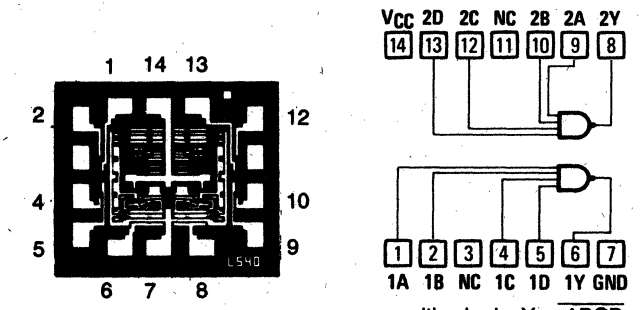
LS37
QUADRUPLE 2-INPUT NAND BUFFER



Die Size .045 x .052

positive logic: $Y = \overline{AB}$

LS40
DUAL 4-INPUT NAND BUFFER



Die Size .045 x .052

positive logic: $Y = \overline{ABCD}$

Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
Normalized fan-out from each output, N	High logic level			60			60	
	Low logic level			30			60	
Operating free-air temperature, T_A		-55		125	0		70	°C

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NOR, NAND Buffers

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=−18mA				−1.5			−1.5	V
V_{OH}	V_{CC}=MIN, I_{OH}=−1.2mA	V_{IL}=0.7V	2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V	I_{OL}=12mA		0.25	0.4		0.25	0.4	V
		I_{OL}=22mA					0.35	0.5	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				−0.36			−0.36	mA
I_{OS}	V_{CC}=MAX		−30		−100	−30		−100	mA
I_{CCH}	V_{CC}=MAX, All inputs at 0V	LS28		0.45	0.9		0.45	0.9	mA
		LS37,40		0.23	0.5		0.23	0.5	
I_{CCL}	V_{CC}=MAX, All inputs at 5V	LS28		1.7	3.45		1.7	3.45	mA
		LS37,40		1.5	3.0		1.5	3.0	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	−55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 45pF, R_L = 667Ω (See Fig. A, page 2-147)										
t_{PLH}		6	10		5	9		6	10	ns
t_{PHL}		9	14		7	12		7	11	ns
Test Conditions: C_L = 125pF, R_L = 667Ω (See Fig. A, page 2-147)										
t_{PLH}		8	12		7	11		8	13	ns
t_{PHL}		14	20		10	15		10	15	ns

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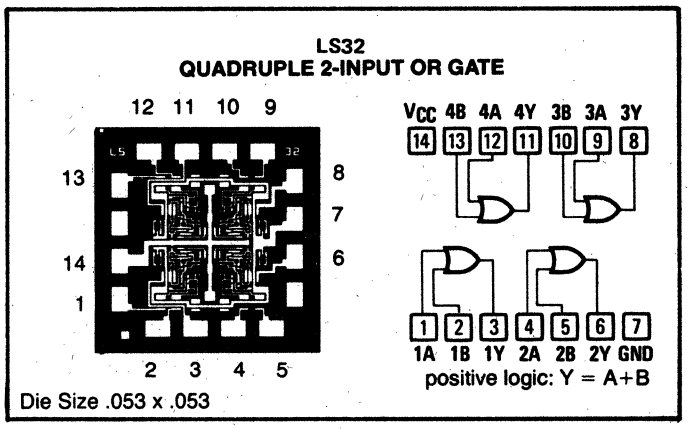
PIN-OUT AND LOGIC DIAGRAM



Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
Normalized fan-out from each output, N	High logic level			20			20	
	Low logic level			10			20	
Operating free-air temperature, T_A		-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, I_{OH}=-400μA, V_{IL}=0.7V		2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.36			-0.36	mA
I_{OS}†	V_{CC}=MAX		-15		-100	-15		-100	mA
I_{CCH}	V_{CC}=MAX, All inputs at 5V			3.1	6.2		3.1	6.2	mA
I_{CCL}	V_{CC}=MAX, All inputs at 0V			4.9	9.8		4.9	9.8	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	-55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A, page 2-147)										
t_{PLH}		7	12		7	11		9	13	ns
t_{PHL}		7	13		7	12		9	14	ns
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. A, page 2-147)										
t_{PLH}		9	14		8	13		10	15	ns
t_{PHL}		11	17		10	15		12	18	ns

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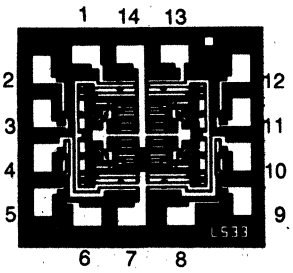
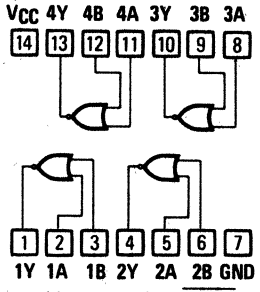
NOR, NAND Buffers With Open-Collector Outputs

LS33 LS38

PIN-OUT AND LOGIC DIAGRAMS

LS33
QUADRUPLE 2-INPUT NOR BUFFER

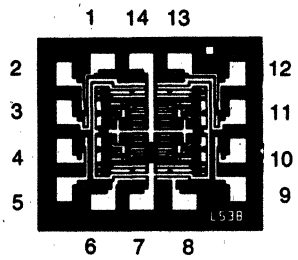


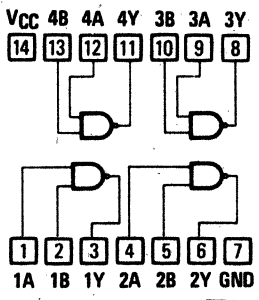


Die Size .045 x .052

positive logic: $Y = \overline{A+B}$

LS38
QUADRUPLE 2-INPUT NAND BUFFER





Die Size .045 x .052

positive logic: $Y = \overline{AB}$

Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC} (See Note 1)	4.5	5	5.5	4.75	5	5.25	V
High-level output voltage, V_{OH}			5.5			5.5	V
Low-level output current, I_{OL}			22			22	mA
Operating free-air temperature, T_A	-55		125				°C

NOTE 1: Voltage values are with respect to network ground terminal.

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
I_{OH}	V_{CC}=MIN, V_{IL}=V_{IL}max	V_{OH}=5.5V			250			250	μA
V_{OL}	V_{CC}=MIN, V_{IH}=2V	I_{OL}=12mA		0.25	0.4		0.25	0.4	V
		I_{OL}=22mA					0.35	0.5	V
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.36			-0.36	mA
I_{CCH}	V_{CC}=MAX, All inputs at 0V	LS33		1.8	3.6		1.8	3.6	mA
		LS38		0.9	2.0		0.9	2.0	
I_{CCL}	V_{CC}=MAX, All inputs at 4.5V	LS33		6.9	13.8		6.9	1.38	mA
		LS38		6.0	12.0		6.0	12.0	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	-55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 45pF, R_L = 667Ω (See Figure B, page 2-147)										
t_{PLH}				7.0	17	25				ns
t_{PHL}				4.0	9	16				ns
Test Conditions: C_L = 125pF, R_L = 667Ω (See Figure B, page 2-147)										
t_{PLH}										ns
t_{PHL}										ns

RAYTHEON
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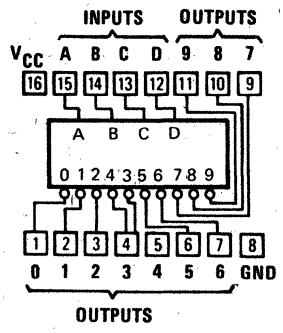
4-Line To 10-Line Decoders (1-of-10)

FEATURES

- All Outputs Are High for Invalid Input Conditions
- Also for Application as
  - 4-Line to 16-Line Decoders
  - 3-Line to 8-Line Decoders

LS42
BCD-TO-DECIMAL DECODERS
LS43
EXCESS-3-TO-DECIMAL DECODERS
LS44
EXCESS-3-GRAY-TO-DECIMAL-DECODERS

PIN-OUT DIAGRAM



positive logic: see function table

DESCRIPTION

These monolithic decimal decoders consist of eight inverters and ten four-input NAND gates. The inverters are connected in pairs to make BCD input data available for decoding by the NAND gates. Full decoding of valid input logic ensures that all outputs remain off for all invalid input conditions.

The LS42 BCD-to-decimal decoders, the LS43 excess-3-to-decimal decoders, and the LS44 excess-3-gray-to-decimal decoders feature inputs and outputs that are compatible for use with most TTL and other saturated low-level logic circuits.

54LS circuits are characterized for operation over the full military temperature range of −55°C to 125°C; 74LS circuits are characterized for operation from 0°C to 70°C.

NO.	LS42 BCD INPUT				LS43 EXCESS 3-INPUT				LS44 EXCESS 3-GRAY INPUT				ALL TYPES DECIMAL OUTPUT									
	D	C	B	A	D	C	B	A	D	C	B	A	0	1	2	3	4	5	6	7	8	9
0	L	L	L	L	L	L	H	H	L	L	H	L	L	H	H	H	H	H	H	H	H	H
1	L	L	L	H	L	H	L	L	L	H	H	L	H	L	H	H	H	H	H	H	H	H
2	L	L	H	L	L	H	L	H	L	H	H	H	H	H	L	H	H	H	H	H	H	H
3	L	L	H	H	L	H	H	L	L	H	L	H	H	H	H	L	H	H	H	H	H	H
4	L	H	L	L	L	H	H	H	L	H	L	L	H	H	H	H	L	H	H	H	H	H
5	L	H	L	H	H	L	L	L	H	H	L	L	H	H	H	H	H	L	H	H	H	H
6	L	H	H	L	H	L	L	H	H	H	L	H	H	H	H	H	H	H	L	H	H	H
7	L	H	H	H	H	L	H	L	H	H	H	H	H	H	H	H	H	H	H	L	H	H
8	H	L	L	L	H	L	H	H	H	H	H	L	H	H	H	H	H	H	H	H	L	H
9	H	L	L	H	H	H	L	L	H	L	H	L	H	H	H	H	H	H	H	H	H	L
INVALID	H	L	H	L	H	H	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H
	H	L	H	H	H	H	H	L	H	L	L	H	H	H	H	H	H	H	H	H	H	H
	H	H	L	L	H	H	H	H	H	L	L	L	H	H	H	H	H	H	H	H	H	H
	H	H	L	H	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H
	H	H	H	L	L	L	L	H	L	L	L	H	H	H	H	H	H	H	H	H	H	H
	H	H	H	H	L	L	H	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H

H = high level, L = low level

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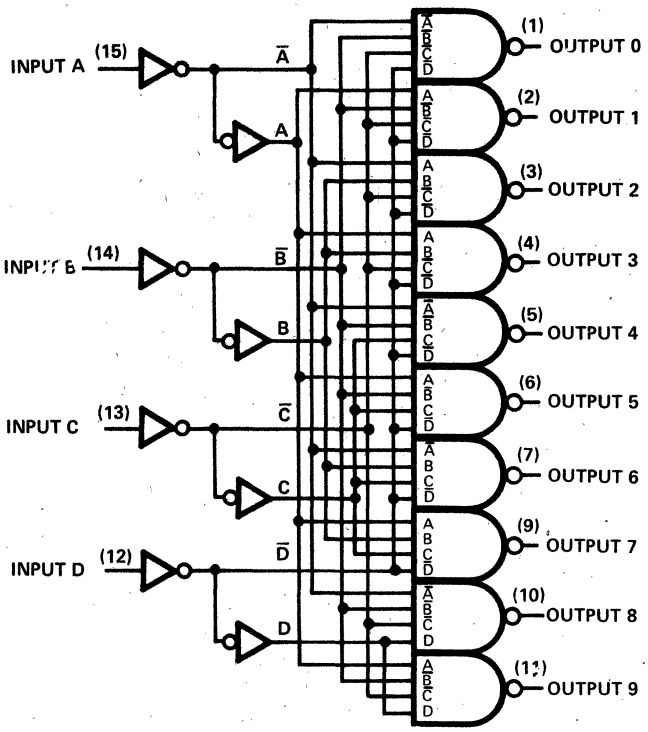
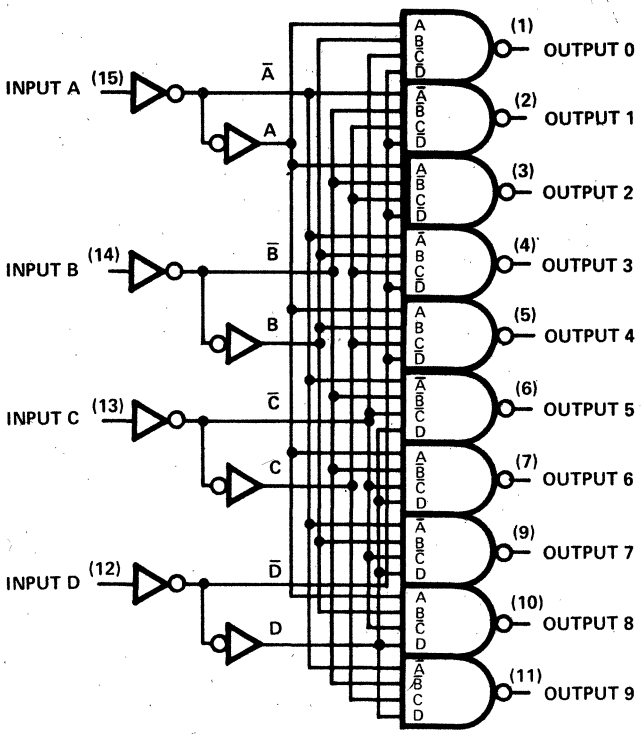
4-Line To 10-Line Decoders (1-of-10) LS42 LS43 LS44

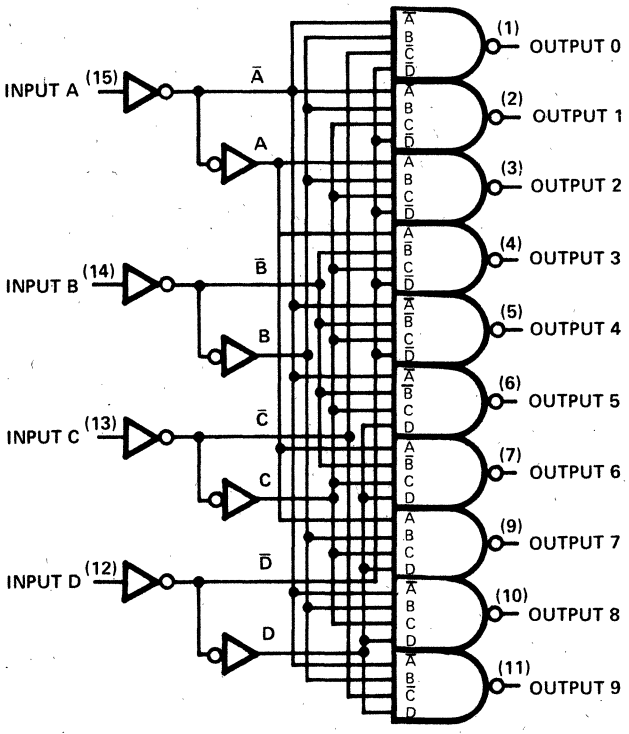
LOGIC DIAGRAMS



LS42
BCD-TO-DECIMAL DECODERS



LS43
EXCESS-3-TO-DECIMAL DECODERS



LS44
EXCESS-3-GRAY-TO-DECIMAL-DECODERS

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Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High level output current, I_{OH}			-400			-400	μA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max I_{OH}=-400μA		2.5	3.5		2.7	3.5		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.4			-0.4	mA
I_{OS}†	V_{CC}=MAX								mA
I_{CC}††	V_{CC}=MAX,			7	13		7	13	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
††I_{CC} is measured with all outputs open and inputs grounded.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	-55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ										
t_{PHL}					14	25				ns
t_{PHL}					17	30				ns
t_{PLH}					10	25				ns
t_{PLH}					17	30				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ										
t_{PHL}										ns
t_{PHL}										ns
t_{PLH}										ns
t_{PLH}										ns

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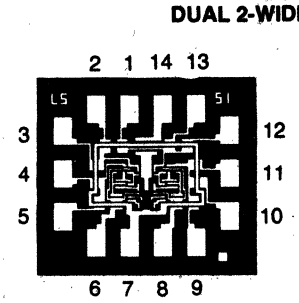
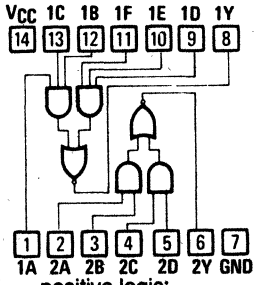
AND-OR-Invert Gates

LS51 LS54 LS55

PIN-OUT AND LOGIC DIAGRAMS

LS51
DUAL 2-WIDE AOI GATE





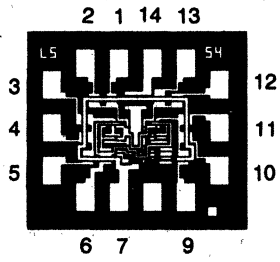
positive logic:

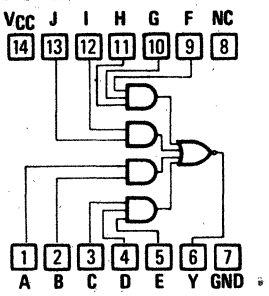
$1Y = \overline{(1A \cdot 1B \cdot 1C) + (1D \cdot 1E \cdot 1F)}$

$2Y = \overline{(2A \cdot 2B) + (2C \cdot 2D)}$

Die Size .041 x .046

LS54
4-WIDE 2-3-3-2-INPUT AOI GATE



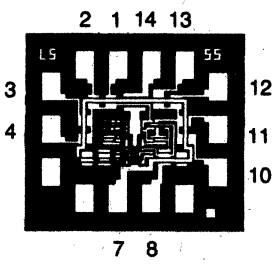


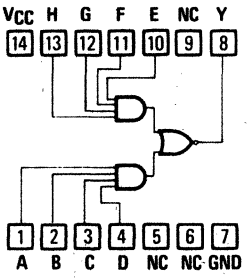
positive logic:

$Y = \overline{(AB) + (CDE) + (FGH) + (IJ)}$

Die Size .041 x .046

LS55
2-WIDE 4-INPUT AOI GATE





positive logic:

$Y = \overline{(ABCD) + (EFGH)}$

Die Size .041 x .046

Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
Normalized fan-out from each output, N	High logic level			20			20	
	Low logic level			10			20	
Operating free-air temperature, T_A		-55		125	0		70	°C

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Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=−18mA				−1.5			−1.5	V
V_{OH}	V_{CC}=MIN, I_{OH}=−400μA	V_{IL}=0.7V	2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				−0.36			−0.36	mA
I_{OS}	V_{CC}=MAX		−15		−100	−15		−100	mA
I_{CCH}	V_{CC}=MAX, See Note 1	LS51		0.8	1.6		0.8	1.6	mA
		LS54		0.8	1.6		0.8	1.6	
		LS55		0.4	0.8		0.4	0.8	
I_{CCL}	V_{CC}=MAX, See Note 2	LS51		1.4	2.8		1.4	2.8	mA
		LS54		1.0	2.0		1.0	2.0	
		LS55		0.7	1.3		0.7	1.3	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

NOTES:
1. I_{CCH} is measured with all inputs grounded, and the outputs open.
2. I_{CCL} is measured with all inputs of one gate at 5V, the remaining inputs grounded, and the outputs open.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	−55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A, page 2-147)										
t_{PLH}		8	13		8.0	13		8	12	ns
t_{PHL}		12	17		8.0	13		9	13	ns
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. A, page 2-147)										
t_{PLH}		13	18		12	18		13	17	ns
t_{PHL}		15	20		12	18		13	17	ns

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Dual J-K Negative-Edge-Triggered Flip-Flops

LS73 LS76 LS107 LS112 LS113

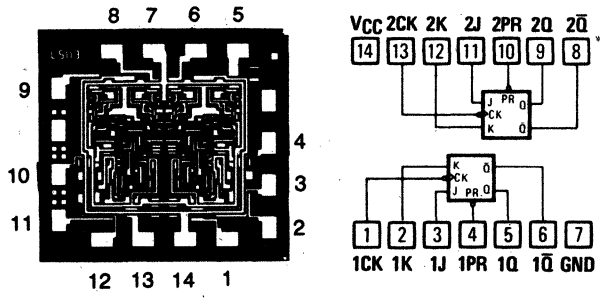
•Pin-for-Pin and functional equivalents to 5473, 5476, 54107, 54S112, 54S113

DESCRIPTION

These monolithic dual J-K flip-flops feature individual J, K, clock, and asynchronous preset and clear inputs to each flip-flop. The preset or clear inputs, when low, set or reset the outputs regardless of the levels at the other inputs. When preset and clear inputs are inactive (high), a high level at the clock input enables the J and K inputs and data will be accepted. The logic levels at the J and K inputs may be allowed to change when the clock pulse is high and the bistable will perform according to the function table as long as minimum setup and hold times are observed. Input data is transferred to the outputs on the negative-going edge of the clock pulse.

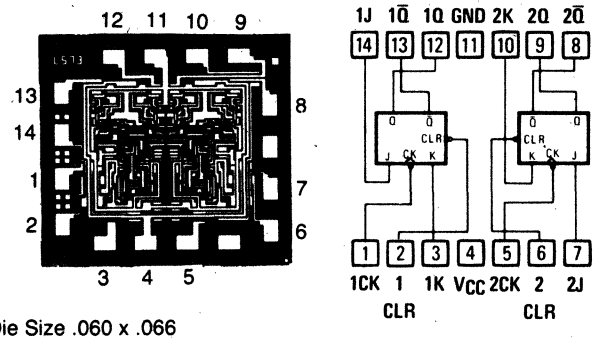
PIN-OUT DIAGRAMS

LS113



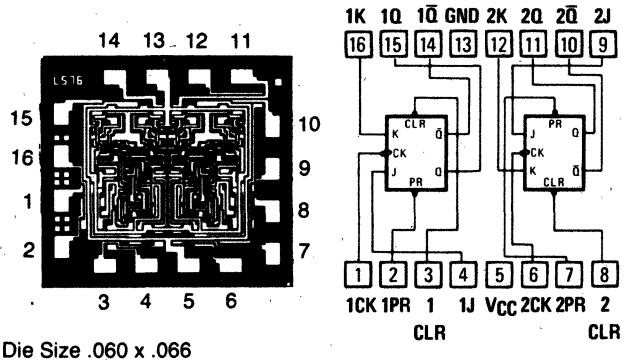
Die Size .060 x .066

LS73



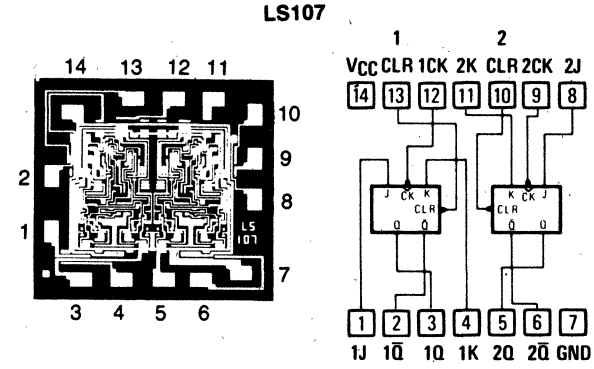
Die Size .060 x .066

LS76



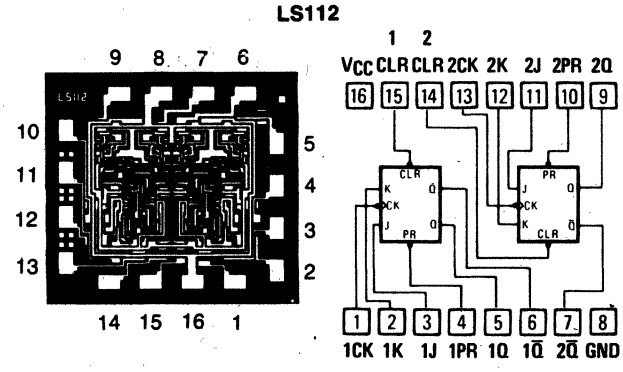
Die Size .060 x .066

LS107



Die Size .060 x .066

LS112



Die Size .060 x .066

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Dual J-K Negative-Edge-Triggered Flip-Flops

Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
Normalized fan-out from each output, N	High logic level			20			20	
	Low logic level			10			20	
Clock frequency, f_{clock}		0		35	0		35	MHz
Width of clock pulse, $t_{w(clock)}$ (High)		15			15			ns
Width of preset pulse, $t_{w(preset)}$ (Low)		15			15			ns
Width of clear pulse, $t_{w(clear)}$ (Low)		15			15			ns
Input setup time, t_{setup}		15			15			ns
Input hold time, t_{hold}		0			0			ns
Operating free-air temperature, T_A		-55		125	0	0	70	°C

t_{setup} is the minimum time required for the correct logic level to be present at the J or K input prior to the falling edge of the clock in order to be recognized and transferred to the outputs.

t_{hold} is the minimum time required for the logic level to be maintained at the J or K input after the falling edge of the clock in order to insure recognition. These devices require no hold time.

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS			9LS/74LS			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-400μA		2.5	3.4		2.7	3.4		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
			I_{OL}=8mA					0.35	0.50	
I_I	J or K					0.1			0.1	mA
	Clock	V_{CC}=MAX, V_I=7V				0.4			0.4	
	Preset or Clear					0.3			0.3	
I_{IH}	J or K					20			20	μA
	Clock	V_{CC}=MAX, V_I=2.7V				80			80	
	Preset or Clear					60			60	
I_{IL}	J or K					-0.36			-0.36	mA
	Clock	V_{CC}=MAX, V_I=0.4V				-0.72			-0.72	
	Preset or Clear					-0.8			-0.8	
I_{OS}†		V_{CC}=MAX		-15		-100	-15		-100	mA
I_{CC}††		V_{CC}=MAX, See Note 1			4	8		4	8	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
†† I_{CC} is measured with outputs open, with clock, J, K, and clear grounded and preset at 4.5V; then with clock, J, K, and preset grounded and clear at 4.5V.

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Dual J-K Negative-Edge-Triggered Flip-Flops

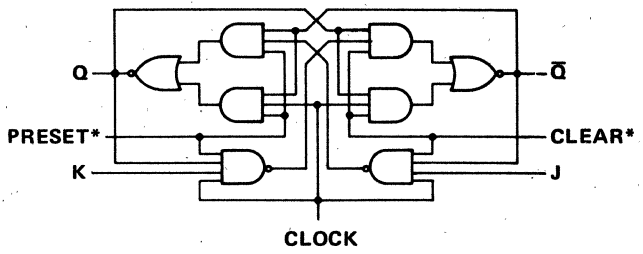
LS73 LS76 LS107 LS112 LS113

LS76, LS112 FUNCTION TABLE (EACH FLIP-FLOP)

INPUTS					OUTPUTS	
PRESET	CLEAR	CLOCK	J	K	Q	$\bar{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	↓	L	L	Q_0	$\bar{Q}_0$
H	H	↓	H	L	H	L
H	H	↓	L	H	L	H
H	H	↓	H	H	TOGGLE	
H	H	H	X	X	Q_0	$\bar{Q}_0$

H = high level (steady-state)
L = low level (steady-state)
X = don't care
↓ = transition from high to low level
Q_0 = the level of Q before the indicated steady-state input conditions were established.
TOGGLE: Each output changes to the complement of its previous level on each ↓ clock transition.
*This configuration is nonstable; that is, it will not persist when preset and clear inputs return to their inactive (high) level.

LOGIC DIAGRAM (½)



*

	PRESET	CLEAR
LS73		X
LS76	X	X
LS107		X
LS112	X	X
LS113	X	

LS73, LS107 FUNCTION TABLE (EACH FLIP-FLOP)

INPUTS				OUTPUTS	
CLEAR	CLOCK	J	K	Q	$\bar{Q}$
L	X	X	X	L	H
H	↓	L	L	Q_0	$\bar{Q}_0$
H	↓	H	L	H	L
H	↓	L	H	L	H
H	↓	H	H	TOGGLE	
H	H	X	X	Q_0	$\bar{Q}_0$

H = high level (steady-state)
L = low level (steady-state)
X = don't care
↓ = transition from high to low level
Q_0 = the level of Q before the indicated steady-state input conditions were established.
TOGGLE: Each output changes to the complement of its previous level on each ↓ clock transition.

LS113 FUNCTION TABLE (EACH FLIP-FLOP)

INPUTS				OUTPUTS	
PRESET	CLOCK	J	K	Q	$\bar{Q}$
L	X	X	X	H	L
H	↓	L	L	Q_0	$\bar{Q}_0$
H	↓	H	L	H	L
H	↓	L	H	L	H
H	↓	H	H	TOGGLE	
H	H	X	X	Q_0	$\bar{Q}_0$

H = high level (steady-state)
L = low level (steady-state)
X = don't care
↓ = transition from high to low level
Q_0 = the level of Q before the indicated steady-state input conditions were established.
TOGGLE: Each output changes to the complement of its previous level on each ↓ clock transition.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter		−55°C			+25°C			+125°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A, page 2-147)											
f_{max}					35	50					MHz
t_{PLH}	CLR,PR		8	12		8	12		11	15	ns
t_{PHL}	CLR,PR		14	19		11	17		13	18	ns
t_{PLH}	CK		8	12		8	12		10	14	ns
t_{PHL}	CK		13	18		11	16		11	16	ns
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. A, page 2-147)											
f_{max}											MHz
t_{PLH}	CLR,PR		10	14		10	15		13	17	ns
t_{PHL}	CLR,PR		19	24		17	22		18	23	ns
t_{PLH}	CK		10	14		10	14		14	18	ns
t_{PHL}	CK		18	23		15	20		15	20	ns

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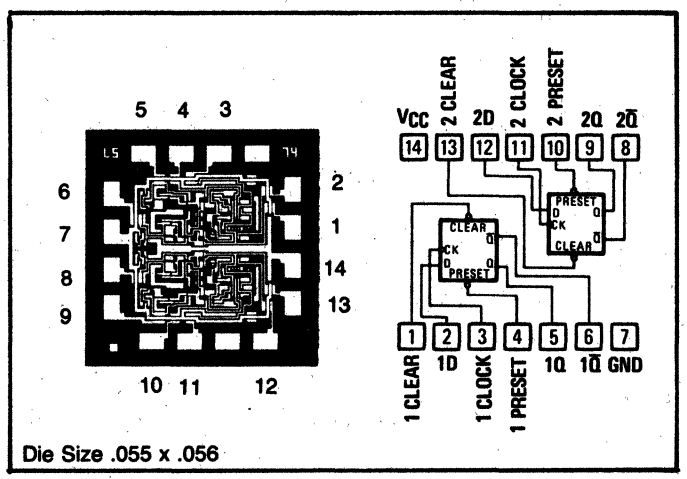
Dual D-Type Positive-Edge-Triggered Flip-Flop

DESCRIPTION

This monolithic dual edge-triggered D-type flip-flop features individual D, clock, preset, and clear inputs.

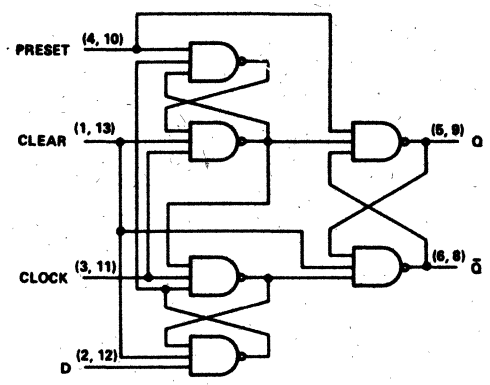
Preset and clear inputs are active-low and operate independently of the clock input. When preset and clear are inactive (high), information at the D input is transferred to the Q output on the positive-going edge of the clock pulse. Clock triggering occurs at a voltage level of the clock pulse and is not directly related to the transition time of the positive-going pulse. When the clock input is at either the high or low level, the D-input signal has no effect at the output.

PIN-OUT DIAGRAM



Die Size .055 x .056

LOGIC DIAGRAM (½)



FUNCTION TABLE (EACH FLIP-FLOP)

INPUTS				OUTPUTS	
PRESET	CLEAR	CLOCK	D	Q	Q̄
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H*	H*
H	H	↑	H	H	L
H	H	↑	L	L	H
H	H	L	X	Q_0	$\bar{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = don't care
↑ = transition from low to high level
Q_0 = the level of Q before the indicated steady-state input conditions were established.
*This configuration is nonstable; that is, it will not persist when preset and clear inputs return to their inactive (high) level.

Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
Normalized fan-out from each output, N	High logic level			20			20	
	Low logic level			10			20	
Clock frequency, f_{clock}		0		30	0		30	MHz
Width of clock pulse, $t_{w(clock)}$ (High)		17			17			ns
Width of preset pulse, $t_{w(preset)}$ (Low)		15			15			ns
Width of clear pulse, $t_{w(clear)}$ (Low)		15			15			ns
Input setup time, t_{setup}	High-level data	10			10			ns
	Low-level data	10			10			
Input hold time, t_{hold}		0			0			ns
Operating free-air temperature, T_A		-55		125	0		70	°C

t_{setup} is the minimum time required for the correct logic level to be present at the D input prior to the rising edge of the clock in order to be recognized and transferred to the outputs.

t_{hold} is the minimum time required for the logic level to be maintained at the D input after the rising edge of the clock in order to insure recognition. This device requires no hold time.

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Dual D-Type Positive-Edge-Triggered Flip-Flop

LS74

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS			9LS/74LS			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=−18mA				−1.5			−1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max I_{OH}=−400μA		2.5	3.4		2.7	3.4		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
			I_{OL}=8mA					0.35	0.50	
I_I	D input					0.1			0.1	mA
	Clock or preset	V_{CC}=MAX, V_I=5.5V				0.2			0.2	
	Clear					0.3			0.3	
I_{IH}	D input					20			20	μA
	Clock or preset	V_{CC}=MAX, V_I=2.7V				40			40	
	Clear					60			60	
I_{IL}	D input					−0.4			−0.4	mA
	Clock or preset	V_{CC}=MAX, V_I=0.4V				−0.8			−0.8	
	Clear					−1.2			−1.2	
I_{OS}†		V_{CC}=MAX		−15		−100	−15		−100	mA
I_{CC}††		V_{CC}=MAX,			4	8		4	8	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

†† I_{CC} is measured with outputs open with D, clock, and preset grounded; then with D, clock, and clear grounded.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter		−55°C			+25°C			+125°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A, page 2-147)											
f_{max}					30	45					MHz
t_{PLH}						10	15				ns
t_{PHL}	CK Low					18	24				ns
	CK High					26	35				
t_{PLH}						12	18				ns
t_{PHL}						14	22				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. A, page 2-147)											
f_{max}											MHz
t_{PLH}											ns
t_{PHL}	CK Low										ns
	CK High										
t_{PLH}											ns
t_{PHL}											ns

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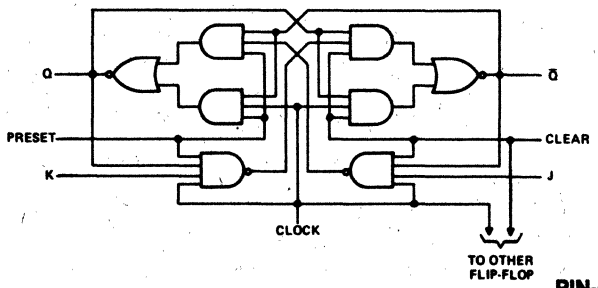
Dual J-K Negative-Edge-Triggered Flip-Flops

DESCRIPTION

These monolithic dual J-K edge-triggered flip-flops feature individual J, K, and preset inputs plus common clock and common clear inputs. The preset or clear inputs, when low, set or reset the outputs regardless of the levels at the other inputs. When preset and clear inputs are inactive (high), a high level at the clock input enables the J and K inputs and data will be accepted. The logic levels at the J and K inputs may be allowed to change when the clock pulse is high and the bistable will perform according to the function table as long as minimum setup and hold times are observed. Input data is transferred to the outputs on the negative-going edge of the clock pulse.

LOGIC DIAGRAM (½)

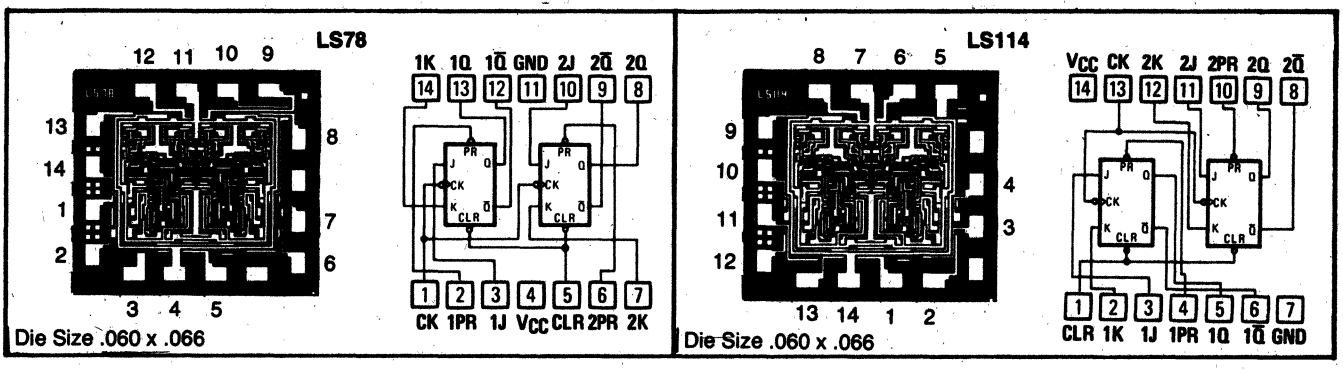


FUNCTION TABLE (EACH FLIP-FLOP)

INPUTS					OUTPUTS	
PRESET	CLEAR	CLOCK	J	K	Q	Q̄
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	↓	L	L	Q_0	$\bar{Q}_0$
H	H	↓	H	L	H	L
H	H	↓	L	H	L	H
H	H	↓	H	H	TOGGLE	
H	H	H	X	X	Q_0	$\bar{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = don't care
↓ = transition from high to low level
Q_0 = the level of Q before the indicated steady-state input conditions were established.
TOGGLE: Each output changes to the complement of its previous level on each ↓ clock transition.
*This configuration is nonstable; that is, it will not persist when preset and clear inputs return to their inactive (high) level.

PIN-OUT DIAGRAMS



Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
Normalized fan-out from each output, N	High logic level			20			20	
	Low logic level			10			20	
Clock frequency, f_{clock}		0		35	0		35	MHz
Width of clock pulse, $t_{w(clock)}$ (High)		15			15			ns
Width of preset pulse, $t_{w(preset)}$ (Low)		15			15			ns
Width of clear pulse, $t_{w(clear)}$ (Low)		15			15			ns
Input setup time, t_{setup}		15			15			ns
Input hold time, t_{hold}		0			0			ns
Operating free-air temperature, T_A		-55		125	0		70	°C

t_{setup} is the minimum time required for the correct logic level to be present at the J or K input prior to the falling edge of the clock in order to be recognized and transferred to the outputs.

t_{hold} is the minimum time required for the logic level to be maintained at the J or K input after the falling edge of the clock in order to insure recognition. These devices require no hold time.

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Dual J-K Negative-Edge-Triggered Flip-Flops

LS78 LS114

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS			9LS/74LS			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=−18mA				−1.5			−1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{CC}=V_{IL}max, I_{OH}=−400μA		2.5	3.4		2.7	3.4		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
			I_{OL}=8mA					0.35	0.5	
I_I	J or K	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
	Preset					0.3			0.3	
	Clear					0.6			0.6	
	Clock					0.8			0.8	
I_{IH}	J or K	V_{CC}=MAX, V_I=2.7V				20			20	μA
	Preset					60			60	
	Clear					120			120	
	Clock					160			160	
I_{IL}	J or K	V_{CC}=MAX, V_I=0.4V				−0.36			−0.36	mA
	Preset					−0.8			−0.8	
	Clear					−1.6			−1.6	
	Clock					−1.44			−1.44	
I_{OS}†		V_{CC}=MAX		−15		−100	−15		−100	mA
I_{CC}††		V_{CC}=MAX,			4	8		4	8	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

†† I_{CC} is measured with outputs open, with clock, J, K, and clear grounded and preset at 4.5V; then with clock, J, K, and preset grounded and clear at 4.5V.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter		−55°C			+25°C			+125°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A, page 2-147)											
f_{max}					35	50					MHz
t_{PLH}	CLR,PR		8	12		8	12		11	15	ns
t_{PHL}	CLR,PR		15	19		13	17		13	17	ns
t_{PLH}	CK		8	12		8	12		11	15	ns
t_{PHL}	CK		14	19		13	18		13	18	ns
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. A, page 2-147)											
f_{max}											MHz
t_{PLH}	CLR,PR		10	14		10	14		13	17	ns
t_{PHL}	CLR,PR		19	24		16	21		16	21	ns
t_{PLH}	CK		9	14		10	14		13	18	ns
t_{PHL}	CK		19	24		17	21		17	22	ns

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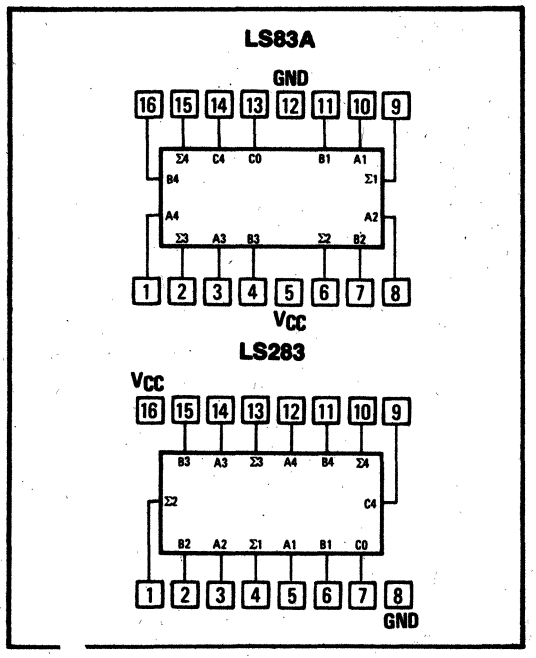
DESCRIPTION

These improved full adders perform the addition of two 4-bit binary numbers. The sum (Σ) outputs are provided for each bit and the resultant carry (C4) is obtained from the fourth bit. These adders feature full internal look ahead across all four bits generating the carry term in ten nanoseconds typically. This provides the system designer with partial look-ahead performance at the economy and reduced package count of a ripple-carry implementation.

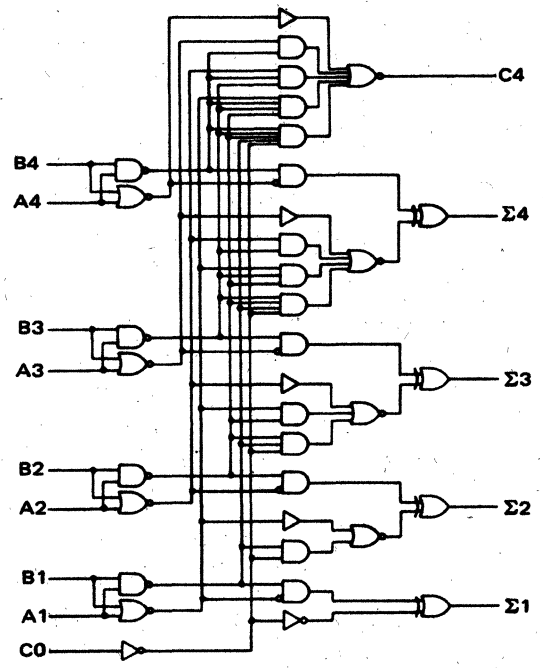
The adder logic, including the carry, is implemented in its true form meaning that the end-around carry can be accomplished without the need for logic or level inversion.

The LS83A and the LS283 are identical in performance; only the pin out is different. They are designed to replace the 5483A and the 54283 respectively. The LS283 is recommended for new designs, V_{CC} and ground on corner pins simplify board layout.

PIN-OUT DIAGRAMS



LOGIC DIAGRAM



FUNCTION TABLE

INPUT				OUTPUT					
				WHEN C0 = L			WHEN C0 = H		
				WHEN C2 = L			WHEN C2 = H		
A1 / A3	B1 / B3	A2 / A4	B2 / B4	Σ1 / Σ3	Σ2 / Σ4	C2 / C4	Σ1 / Σ3	Σ2 / Σ4	C2 / C4
L	L	L	L	L	L	L	H	L	L
H	L	L	L	H	L	L	L	H	L
L	H	L	L	H	L	L	L	H	L
H	H	L	L	L	H	L	H	H	L
L	L	H	L	L	H	L	H	H	L
H	L	H	L	H	H	L	L	L	H
L	H	H	L	H	H	L	L	L	H
H	H	H	L	L	L	H	H	L	H
L	L	L	H	L	H	L	H	H	L
H	L	L	H	H	H	L	L	L	H
L	H	L	H	H	H	L	L	L	H
H	H	L	H	L	L	H	H	L	H
L	L	H	H	L	L	H	H	L	H
H	L	H	H	H	L	H	L	H	H
L	H	H	H	H	L	H	L	H	H
H	H	H	H	L	H	H	H	H	H

H = high level, L = low level

NOTE:

Input conditons at A1, B1, A2, B2, and C0 are used to determine outputs Σ1 and Σ2 and the value of the internal carry C2. The values at C2, A2, B3, A4, and B4 are then used to determine outputs Σ3, Σ4, and C4.

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4-Bit Binary Full Adders With Fast Carry

Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-400			-400	μA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL} max, I_{OH}=-400μA		2.5	3.4		2.7	3.1		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL} max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
I_I Any A or B	V_{CC}=MAX, V_I=7V				0.2			0.2	mA
I_I C0					0.1			0.1	
I_{IH} Any A or B	V_{CC}=MAX, V_I=2.7V				40			40	μA
I_{IH} C0					20			20	
I_{IL} Any A or B	V_{CC}=MAX, V_I=0.4V				-0.8			-0.8	mA
I_{IL} C0					-0.4			-0.4	
I_{OS}†	V_{CC}=MAX		-15		-100	-15		-100	mA
I_{CC}	V_{CC}=MAX, Outputs open	All inputs grounded		22	39		22	39	mA
		All B low, other inputs at 4.5V		19	34		19	34	
		All inputs at 4.5V		19	34		19	34	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter ¶	From (Input)	To (output)	-55°C			+25°C			+125°C			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ												
t_{PLH}	C0	Any Σ		15	20		14	19		15	21	ns
t_{PHL}				15	21		16	22		20	27	
t_{PLH}	A_i or B_i	Σ_i		20	30		18	24		21	27	ns
t_{PHL}				19	29		15	24		17	25	
t_{PLH}	C0	C4		9	14		7	12		11	18	ns
t_{PHL}				9	14		9	13		11	16	
t_{PLH}	A_i or B_i	C4		9	15		8	13		11	17	ns
t_{PHL}				10	14		9	14		11	16	
Test Conditions: C_L = 50pF, R_L = 2kΩ												
t_{PLH}	C0	Any Σ		16	21		15	20		17	22	ns
t_{PHL}				19	25		19	25		25	30	
t_{PLH}	A_i or B_i	Σ_i		25	32		18	26		25	32	ns
t_{PHL}				24	30		18	26		25	31	
t_{PLH}	C0	C4		11	16		10	15		12	19	ns
t_{PHL}				12	17		10	16		13	18	
t_{PLH}	A_i or B_i	C4		11	17		10	15		13	19	ns
t_{PHL}				13	18		12	16		14	20	

NOTE 1: ¶ t_{PLH} ≡ Propagation delay time low-to-high-level output
t_{PLH} ≡ Propagation delay time high-to-low-level output

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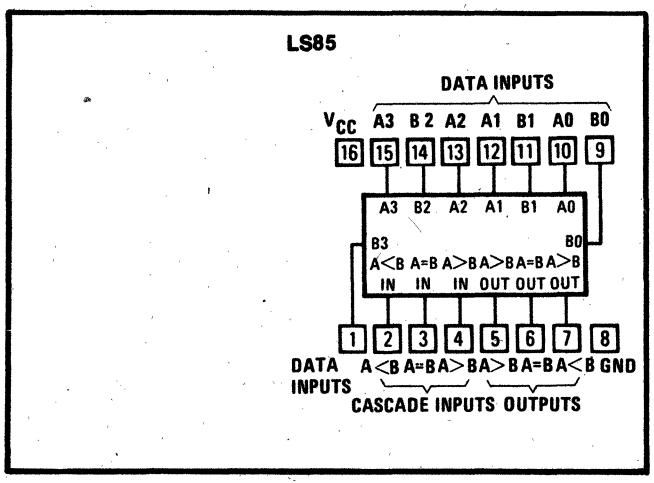
DESCRIPTION

These four-bit magnitude comparators perform comparison of straight binary and straight BCD (8-4-2-1) codes. Three fully decoded decisions about two 4-bit words (A,B) are made and are externally available at three outputs. These devices are fully expandable to any number of bits without external gates. Words of greater length may be compared by connecting comparators in cascade. The A > B, A < B, and A = B outputs of a stage handling less-significant bits are connected to the corresponding A > B, A < B, and A =B inputs of the next stage handling more-significant bits. The stage handling the least-significant bits must have a high-level voltage applied to the A = B input. The cascading paths of the '85, and 'LS85 are implemented with only a two-gate-level delay to reduce overall comparison times for long words. An alternate method of cascading which further reduces the comparison time is shown in the typical application data.

PIN-OUT AND LOGIC DIAGRAM



FUNCTION TABLES

COMPARING INPUTS				CASCADING INPUTS			OUTPUTS		
A3, B3	A2, B2	A1, B1	A0, B0	A>B	A<B	A=B	A>B	A<B	A=B
A3>B3	X	X	X	X	X	X	H	L	L
A3<B3	X	X	X	X	X	X	L	H	L
A3 = B3	A2>B2	X	X	X	X	X	H	L	L
A3 = B3	A2<B2	X	X	X	X	X	L	H	L
A3 = B2	A2 = B2	A1>B1	X	X	X	X	H	L	L
A3 = B3	A2 = B2	A1<B1	X	X	X	X	L	H	L
A3 = B3	A2 = B2	A1 = B1	A0>B0	X	X	X	H	L	L
A3 = B3	A2 = B2	A1 = B1	A0<B0	X	X	X	L	H	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	H	L	L	H	L	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	L	H	L	L	H	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	L	L	H	L	L	H
A3 = B3	A2 = B2	A1 = B1	A0 = B0	X	X	H	L	L	H
A3 = B3	A2 = B2	A1 = B1	A0 = B0	H	H	L	L	L	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	L	L	L	H	H	L

H = high level; L = low level, X = irrelevant

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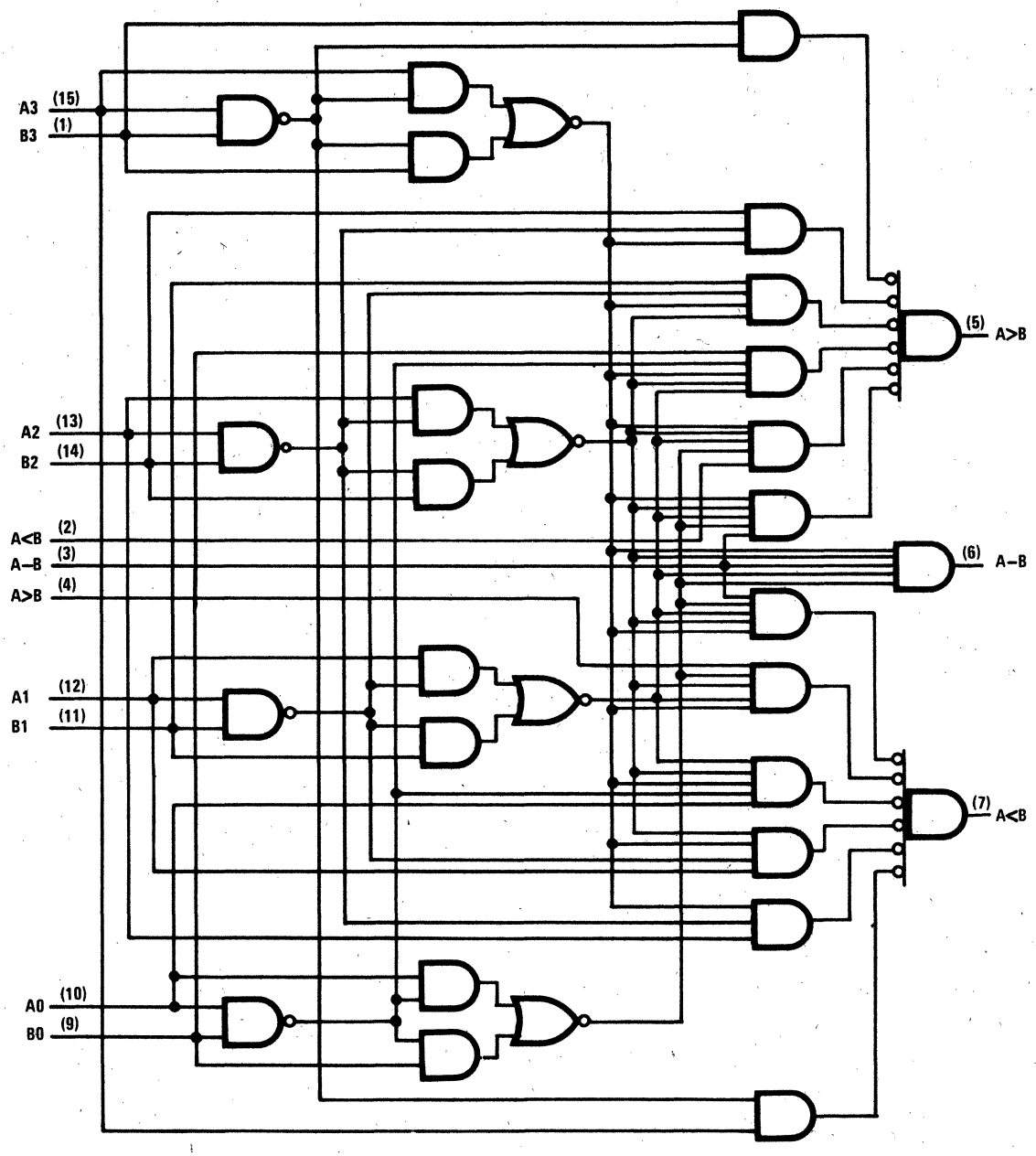
4-Bit Magnitude Comparators

LOGIC DIAGRAM



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Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-400			-400	μA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS			9LS/74LS			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-400μA		2.4	3.4		2.4	3.4		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
			I_{OL}=8mA					0.35	0.5	
I_I	A<B, A>B inputs	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
	all other inputs					0.3			0.3	
I_{IH}	A<B, A>B inputs	V_{CC}=MAX, V_I=2.7V				20			20	μA
	all other inputs					60			60	
I_{IL}	A<B, A>B inputs	V_{CC}=MAX, V_I=0.4V				-0.4			-0.4	mA
	all other inputs					-1.2			-1.2	
I_{OS}†		V_{CC}=MAX		-6		-40	-5		-42	mA
I_{CC}††		V_{CC}=MAX,			10.4	20		10.4	20	mA

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter*	From (Input)	To (output)	No. of Gate Levels	-55°C			+25°C			+125°C			Unit
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ													
t_{PLH}	Any A or B data input	A<B, A>B	1					14					ns
			2					19					
			3					24	36				
		A = B	4					23	35				
t_{PHL}	Any A or B data input	A<B, A>B	1					11					ns
			2					15					
			3					20	30				
		A = B	4					20	30				
t_{PLH}	A<B or A = B	A > B	1					14	22				ns
t_{PHL}	A<B or A = B	A > B	1					11	17				ns
t_{PLH}	A = B	A = B	2					13	20				ns
t_{PHL}	A = B	A = B	2					11	17				ns
t_{PLH}	A>B or A = B	A < B	1					14	22				ns
t_{PHL}	A>B or A = B	A < B	1					11	17				ns

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

††I_{CC} is measured with outputs open, A = B grounded, and all other inputs at 4.5V.

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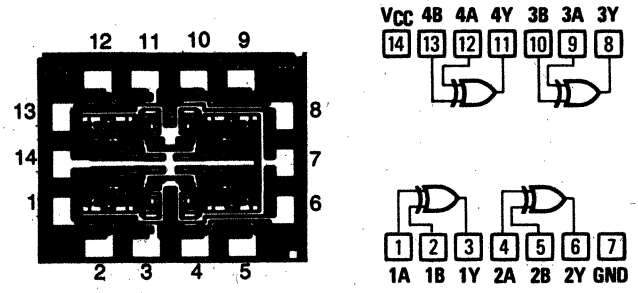
Quadruple 2-Input Exclusive-OR Gates

LS86 LS386

PIN-OUT AND LOGIC DIAGRAMS

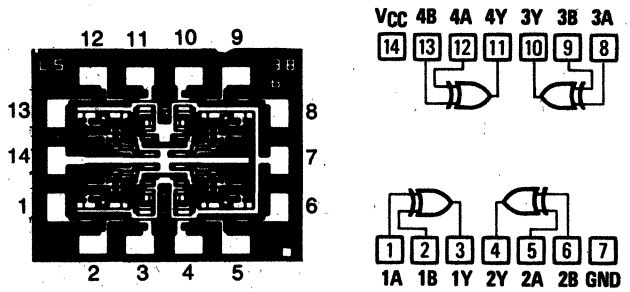
LS86



Die Size .045 x .056

positive logic: $Y = A \oplus B = \bar{A}B + A\bar{B}$

LS386



Die Size .045 x .056

positive logic: $Y = A \oplus B = \overline{A}B + A\bar{B}$

LS86 and LS386 are electrically identical. The LS386 is a pin-for-pin replacement for the L386.

Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-400			-400	μA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-400μA		2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max,	I_{OL}=4mA		0.25	0.4	0.25	0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
I_I	V_{CC}=MAX, V_I=7V				0.2			0.2	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				40			40	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.6			-0.6	mA
I_{OS}†	V_{CC}=MAX		-15		-100	-15		-100	mA
I_{CC}††	V_{CC}=MAX,			6.1	10		6.1	10	mA

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	From (input)		−55°C			+25°C			+125°C			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ												
t_{PLH}	A or B	Other input low					8	13				ns
t_{PHL}							8	13				
t_{PLH}	A or B	Other input high					8	13				ns
t_{PHL}							8	13				

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

††I_{CC} is measured with the inputs grounded and the outputs open.

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Decade, Divide-by-Twelve, and Binary Counters

DESCRIPTION

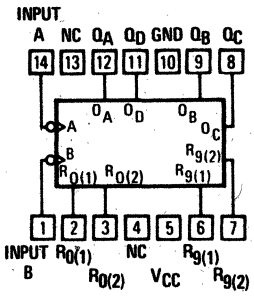
Each of these monolithic counters contains four master-slave flip-flops and additional gating to provide a divide-by-two counter and a three-stage binary counter for which the count cycle length is divide-by-five for the 'LS90, divide-by-six for the 'LS92, and divide-by-eight for the 'LS93.

All of these counters have a gated zero reset and 'LS90 also has gated set-to-nine inputs for use in BCD nine's complement applications.

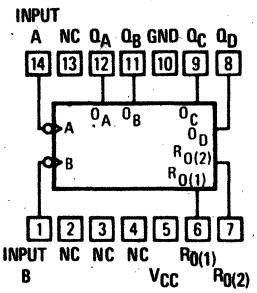
To use their maximum count length (decade, divide-by-twelve, or four-bit binary) of these counters, the B input is connected to the Q_A output. The input count pulses are applied to input A and the outputs are as described in the appropriate function table. A symmetrical divide-by-ten count can be obtained from the 'LS90 counters by connecting the Q_D output to the A input and applying the input count to the B input which gives a divide-by-ten square wave at output Q_A.

PIN-OUT DIAGRAMS

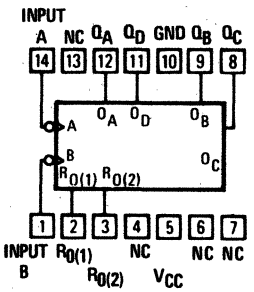
LS90



LS92



LS93



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Decade, Divide-by-Twelve, and Binary Counters

LS90 LS92 LS93

LS90
BCD COUNT SEQUENCE
(See Note A)

COUNT	OUTPUT			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

LS90
BI-QUINARY (5-2)
(See Note B)

COUNT	OUTPUT			
	Q_A	Q_D	Q_C	Q_B
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	H	L	L	L
6	H	L	L	H
7	H	L	H	L
8	H	L	H	H
9	H	H	L	L

LS92
COUNT SEQUENCE
(See Note C)

COUNT	OUTPUT			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	H	L	L	L
7	H	L	L	H
8	H	L	H	L
9	H	L	H	H
10	H	H	L	L
11	H	H	L	H

LS93
COUNT SEQUENCE
(See Note C)

COUNT	OUTPUT			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H
10	H	L	H	L
11	H	L	H	H
12	H	H	L	L
13	H	H	L	H
14	H	H	H	L
15	H	H	H	H

LS90
RESET/COUNT FUNCTION TABLE

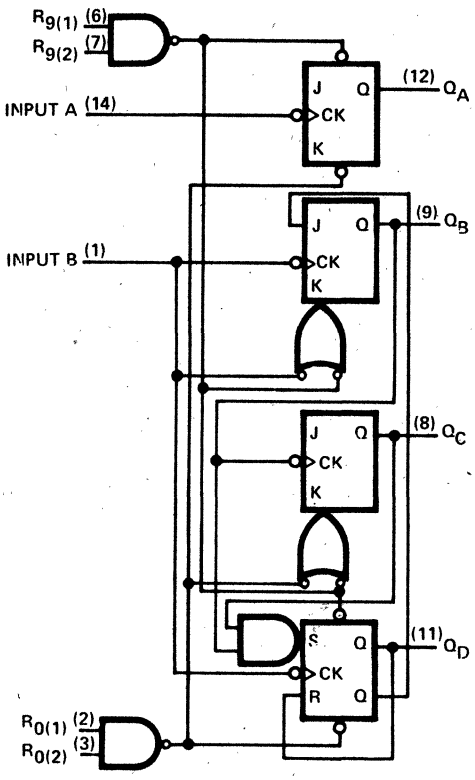
RESET INPUTS				OUTPUT			
$R_{0(1)}$	$R_{0(2)}$	$R_{9(1)}$	$R_{9(2)}$	Q_D	Q_C	Q_B	Q_A
H	H	L	X	L	L	L	L
H	H	X	L	L	L	L	L
X	X	H	H	H	L	L	H
X	L	X	L	COUNT			
L	X	L	X	COUNT			
L	X	X	L	COUNT			
X	L	L	X	COUNT			

LS93
RESET/COUNT FUNCTION TABLE

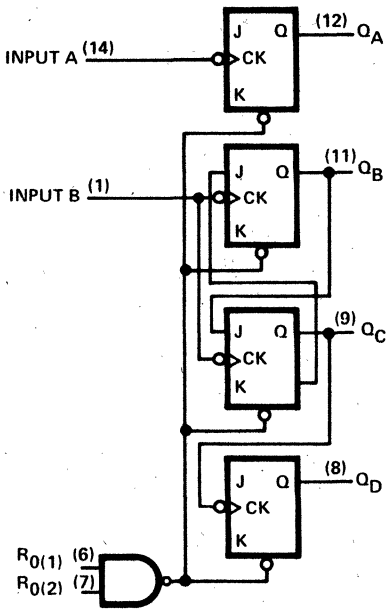
RESET INPUTS		OUTPUT			
$R_{0(1)}$	$R_{0(2)}$	Q_D	Q_C	Q_B	Q_A
H	H	L	L	L	L
L	X	COUNT			
X	L	COUNT			

NOTES:
A. Output Q_A is connected to input B for BCD count.
B. Output Q_D is connected to input A for bi-quinary count.
C. Output Q_A is connected to input B.
D. H = high level, L = low level, X = irrelevant

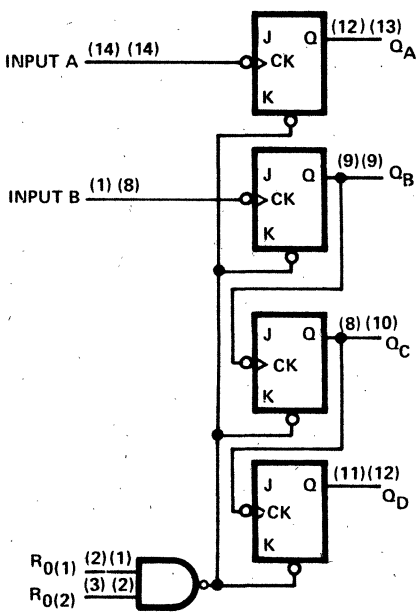
LS90



LS92



LS93



LOGIC DIAGRAMS

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Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}				-400			-400	μA
Low-level output current, I_{OL}				4			8	mA
Count frequency, f_{count} (see Figure 1 on 2-46)	A input	0		32	0		32	MHz
	B input	0		16	0		16	
Pulse width, t_w	A input	15			15			ns
	B input	30			30			
	Reset inputs	15			15			
Reset inactive-state setup time, t_{setup}		25			25			ns
Operating free-air temperature, T_A		-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS			9LS/74LS			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-400μA		2.5	3.4		2.7	3.4		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max,	I_{OL}=4mA¶		0.25	0.4		0.25	0.4	V
			I_{OL}=8mA¶					0.35	0.5	
I_I	Any reset	V_{CC}=MAX, V_I=7V				0.1			0.1	
	A input	V_{CC}=MAX, V_I=5.5V				0.4			0.4	mA
	B input					0.8			0.8	
I_{IH}	Any reset	V_{CC}=MAX, V_I=2.7V				20			20	μA
	A input					80			80	
	B input					160			160	
I_{IL}	Any reset	V_{CC}=MAX, V_I=0.4V				-0.4			-0.4	mA
	A input					-2.4			-2.4	
	B input					-3.2			-3.2	
I_{OS}†		V_{CC}=MAX		-6		-40	-5		-42	mA
I_{CC}††		V_{CC}=MAX,	LS90		9	15		9	15	mA
			LS92		9	15		9	15	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

†† I_{CC} is measured with all outputs open, both R_0 inputs grounded following momentary connection to 4.5V, and all other inputs grounded.

¶ Outputs are tested at specified I_{OL} plus the limit value of I_{IL} for the B input. This permits driving the B input while maintaining full fan-out capability.

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Decade, Divide-by-Twelve, and Binary Counters

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS			9LS/74LS			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=−18mA				−1.5			−1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=−400μA		2.5	3.4		2.7	3.4		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA¶		0.25	0.4		0.25	0.4	V
			I_{OL}=8mA¶					0.35	0.5	
I_I	Any reset	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
	A or B input	V_{CC}=MAX, V_I=5.5V				0.4			0.4	
I_{IH}	Any reset	V_{CC}=MAX, V_I=2.7V				20			20	μA
	A or B input					80			80	
I_{IL}	Any reset					−0.4			−0.4	
	A input	V_{CC}=MAX, V_I=0.4V				−2.4			−2.4	mA
	B input					−1.6			−1.6	
I_{OS}†		V_{CC}=MAX		−6		−40	−5		−42	mA
I_{CC}††		V_{CC}=MAX,			9	15		9	15	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

†† I_{CC} is measured with all outputs open, both R_0 inputs grounded following momentary connection to 4.5V, and all other inputs grounded.

¶ Outputs are tested at specified I_{OL} plus the limit value of I_{IL} for the B input. This permits driving the B input while maintaining full fan-out capability.

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Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter¶		From (Input)	To (output)	−55°C			+25°C			+125°C			Unit
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ													
f_{max}	LS90	A	Q_A				32	42					MHz
		B	Q_B				16						
f_{max}	LS92	A	Q_A				32	42					MHz
		B	Q_B				16						
f_{max}	LS93	A	Q_A				32	42					MHz
		B	Q_B				16						
t_{PLH}	LS90	A	Q_A					10	16				ns
t_{PHL}								12	18				
t_{PLH}	LS92	A	Q_A					10	16				ns
t_{PHL}								12	18				
t_{PLH}	LS93	A	Q_A					10	16				ns
t_{PHL}								12	18				
t_{PLH}	LS90	A	Q_D					32	48				ns
t_{PHL}								34	50				
t_{PLH}	LS92	A	Q_D					32	48				ns
t_{PHL}								34	50				
t_{PLH}	LS93	A	Q_D					46	70				ns
t_{PHL}								46	70				
t_{PLH}	LS90	B	Q_B					10	16				ns
t_{PHL}								14	21				
t_{PLH}	LS92	B	Q_B					10	16				ns
t_{PHL}								14	21				
t_{PLH}	LS93	B	Q_B					10	16				ns
t_{PHL}								14	21				
t_{PLH}	LS90	B	Q_C					21	32				ns
t_{PHL}								23	35				
t_{PLH}	LS92	B	Q_C					10	16				ns
t_{PHL}								14	21				
t_{PLH}	LS93	B	Q_C					21	32				ns
t_{PHL}								23	35				
t_{PLH}	LS90	B	Q_D					21	32				ns
t_{PHL}								23	35				
t_{PLH}	LS92	B	Q_D					21	32				ns
t_{PHL}								23	35				
t_{PLH}	LS93	B	Q_D					34	51				ns
t_{PHL}								34	51				
t_{PHL}	LS90	Set-to-0	Any					26	40				ns
t_{PHL}	LS92	Set-to-0	Any					26	40				ns
t_{PHL}	LS93	Set-to-0	Any					26	40				ns
t_{PLH}	LS90	Set-to-9	Q_A, Q_D					20	30				ns
t_{PHL}			Q_B, Q_C					26	24				

¶ f_{max} = maximum count frequency
t_{PLH} = propagation delay time, low to high level output
t_{PHL} = propagation delay time, high to low level output

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Decade, Divide-by-Twelve, and Binary Counters

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter¶		From (input)	To (output)	−55°C			+25°C			+125°C			Unit
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ													
f_{max}	LS90	A	Q_A										MHz
		B	Q_B										
f_{max}	LS92	A	Q_A										MHz
		B	Q_B										
f_{max}	LS93	A	Q_A										MHz
		B	Q_B										
t_{PLH} / t_{PHL}	LS90	A	Q_A										ns
t_{PLH} / t_{PHL}	LS92	A	Q_A										ns
t_{PLH} / t_{PHL}	LS93	A	Q_A										ns
t_{PLH} / t_{PHL}	LS90	A	Q_D										ns
t_{PLH} / t_{PHL}	LS92	A	Q_D										ns
t_{PLH} / t_{PHL}	LS93	A	Q_D										ns
t_{PLH} / t_{PHL}	LS90	B	Q_B										ns
t_{PLH} / t_{PHL}	LS92	B	Q_B										ns
t_{PLH} / t_{PHL}	LS93	B	Q_B										ns
t_{PLH} / t_{PHL}	LS90	B	Q_C										ns
t_{PLH} / t_{PHL}	LS92	B	Q_C										ns
t_{PLH} / t_{PHL}	LS93	B	Q_C										ns
t_{PLH} / t_{PHL}	LS90	B	Q_D										ns
t_{PLH} / t_{PHL}	LS92	B	Q_D										ns
t_{PLH} / t_{PHL}	LS93	B	Q_D										ns
t_{PHL}	LS90	Set-to-0	Any										ns
t_{PHL}	LS92	Set-to-0	Any										ns
t_{PHL}	LS93	Set-to-0	Any										ns
t_{PLH} / t_{PHL}	LS90	Set-to-9	Q_A, Q_D										ns
			Q_B, Q_C										

¶ f_{max} = maximum count frequency
t_{PLH} = propagation delay time, low to high level output
t_{PHL} = propagation delay time, high to low level output

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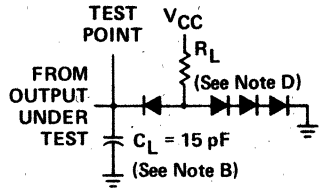
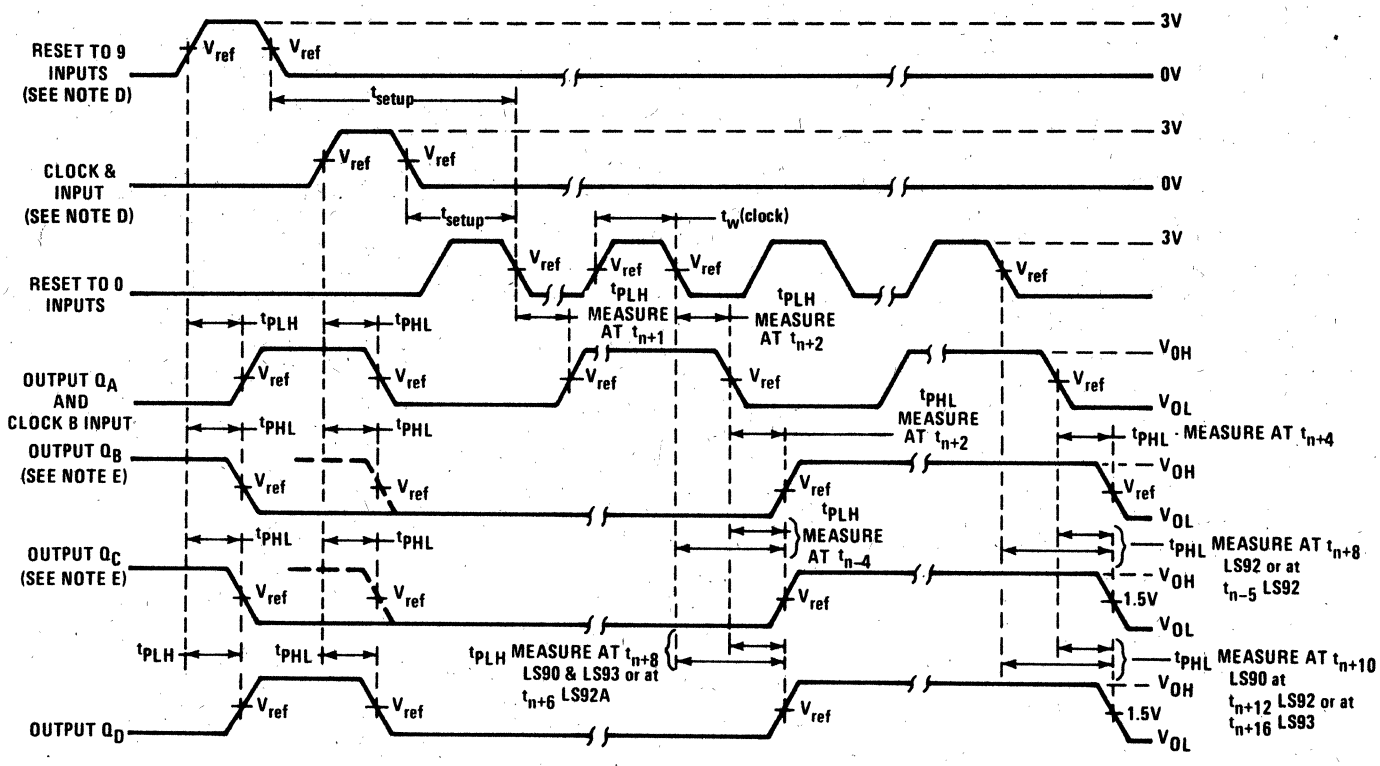
PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT



NOTES: A. Input pulses are supplied by a generator having the following characteristics:
For LS90, LS92, LS93, $t_r \leq 15$ns, $t_f \leq 5$ns, PRR = 1 MHz, duty cycle = 50%, Z_{out} = 50 ohms
B. C_L includes probe and jig capacitance.
C. All diodes are 1N916 or 1N3064.
D. Each reset input is tested separately with the other reset at 4.5V.
E. Reference waveforms are shown with dashed lines.
F. L93, LS90, LS92, and LS93 V_{ref} = 1.3V.

FIGURE 1. VOLTAGE WAVEFORMS

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4-Bit Bi-Directional Parallel-Access Shift Register

LS95B

DESCRIPTION

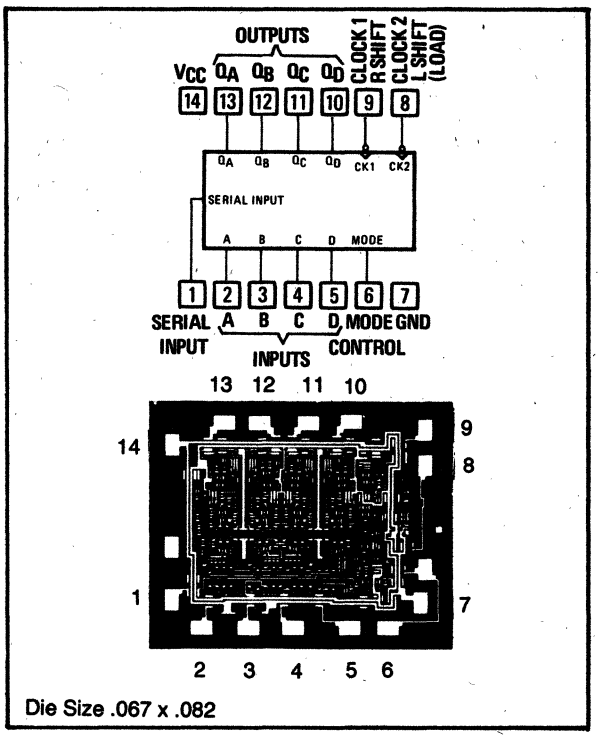
This 4-bit register features parallel and serial inputs, parallel outputs, mode control, and two clock inputs. The register has three modes of operation:

Parallel (broadside) load
Shift right (the direction Q_A toward Q_D)
Shift left (the direction Q_D toward Q_A)

Parallel loading is accomplished by applying the four bits of data and taking the mode control input high. The data is loaded into the associated flip-flops and appears at the outputs after the high-to-low transition of the clock-2 input. During loading, the entry of serial data is inhibited.

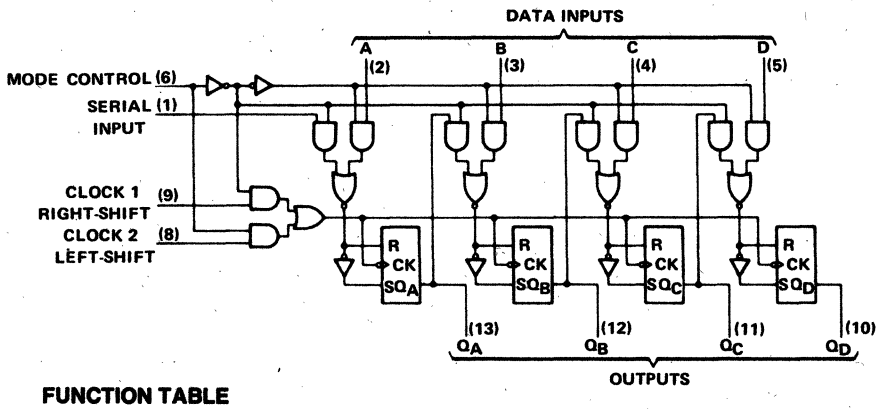
Shift right is accomplished on the high-to-low transition of clock 1 when the mode control is low; shift left is accomplished on the high-to-low transition of clock 2 when the mode control is high by connecting the output of each flip-flop to the parallel input of the previous flip-flop (Q_D to input C, etc.) and serial data is entered at input D. The clock input may be applied commonly to clock 1 and clock 2 if both modes can be clocked from the same source. Changes at the mode control input should normally be made while both clock inputs are low; however, conditions described in the last three lines of the function table will also ensure that register contents are protected.

PIN-OUT DIAGRAM



Die Size .067 x .082

LOGIC DIAGRAM



FUNCTION TABLE

INPUTS								OUTPUTS			
MODE CONTROL	CLOCKS 2 (L)	CLOCKS 1 (R)	SERIAL	PARALLEL A	PARALLEL B	PARALLEL C	PARALLEL D	Q_A	Q_B	Q_C	Q_D
H	H	X	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
H	↓	X	X	a	b	c	d	a	b	c	d
H	↓	X	X	Q_B†	Q_C†	Q_D†	d	Q_{Bn}	Q_{Cn}	Q_{Dn}	d
L	L	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
L	X	↓	H	X	X	X	X	H	Q_{An}	Q_{Bn}	Q_{Cn}
L	X	↓	L	X	X	X	X	L	Q_{An}	Q_{Bn}	Q_{Cn}
↑	L	L	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
↓	L	L	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
↓	L	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
↑	H	L	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
↑	H	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}

†Shifting left requires external connection of Q_B to A, Q_C to B, and Q_D to C. Serial data is entered at input D.

H = high level (steady state), L = low level (steady state), X = irrelevant (any input, including transitions)

↓ = transition from high to low level, ↑ = transition from low to high level

a, b, c, d = the level of steady-state input at input, A, B, C, or D, respectively.

Q_{A0}, Q_{B0}, Q_{C0}, Q_{D0} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the indicated steady-state input conditions were established.

Q_{An}, Q_{Bn}, Q_{Cn}, Q_{Dn} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the most-recent ↓ transition of the clock.

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Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-400			-400	μA
Low-level output current, I_{OL}			4			8	mA
Clock frequency, f_{clock}	0		20	0		20	MHz
Width of clock pulse, $t_{w(clock)}$ (see Figure 1 page 2-49)	25			25			ns
Setup time, high-level or low-level data, t_{setup} (see Figure 1 page 2-49)	0			0			ns
Hold time, high-level or low-level data, t_{hold} (see Figure 1 page 2-49)	20			20			ns
Time to enable clock 1, $t_{enable\ 1}$ (see Figure 2 page 2-49)	20			20			ns
Time to enable clock 2, $t_{enable\ 2}$ (see Figure 2 page 2-49)	20			20			ns
Time to inhibit clock 1, $t_{inhibit\ 1}$ (see Figure 2 page 2-49)	10			10			ns
Time to inhibit clock 2, $t_{inhibit\ 2}$ (see Figure 2 page 2-49)	10			10			ns
Operating free-air temperature T_A	-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS			9LS/74LS			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL} max, I_{OH}=-400μA		2.5	3.4		2.7	3.4		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL} max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
			I_{OL}=8mA					0.35	0.5	
I_I	Clock inputs	V_{CC}=MAX, V_I=7V				0.2			0.2	mA
	Other inputs					0.1			0.1	
I_{IH}	Clock inputs	V_{CC}=MAX, V_I=2.7V				40			40	μA
	Other inputs					20			20	
I_{IL}	Clock inputs	V_{CC}=MAX, V_I=0.4V				-0.8			-0.8	mA
	Other inputs					-0.4			-0.4	
I_{OS}†		V_{CC}=MAX,		-15		-100	-15		-100	mA
I_{CC}††		V_{CC}=MAX, See Note 1			13	21		13	21	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

†† I_{CC} is measured with all outputs and serial inputs open; A, B, C, and D inputs grounded; mode control at 4.5V; and a momentary 3V then ground, applied to both clock inputs.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	-55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Figure 1 on page 2-49)										
f_{max}				20	30					MHz
t_{PLH}					27	35				ns
t_{PHL}					30	40				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Figure 1 on page 2-49)										
f_{max}										MHz
t_{PLH}										ns
t_{PHL}										ns

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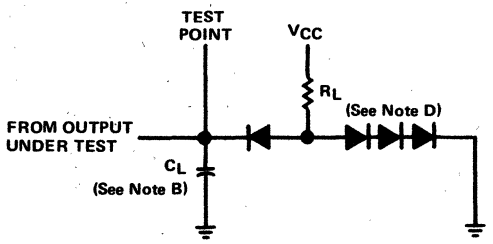
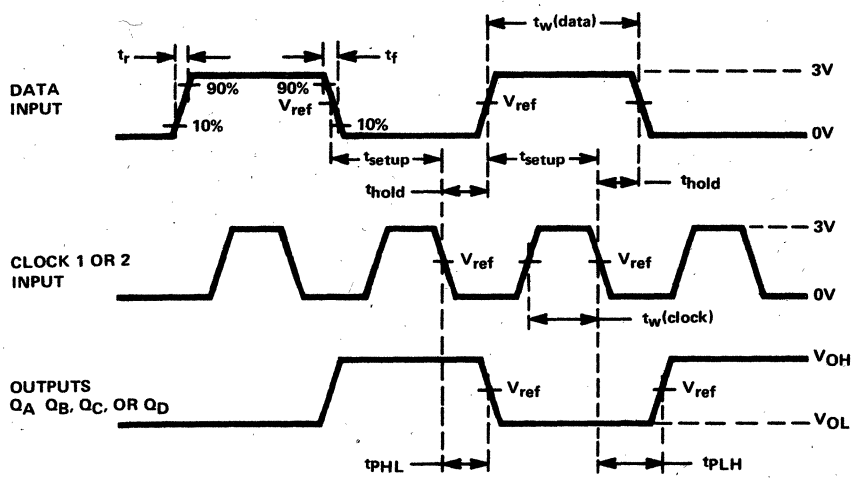
4-Bit Bi-Directional Parallel-Access Shift Register

PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT



VOLTAGE WAVEFORMS

FIGURE 1 – SWITCHING TIMES

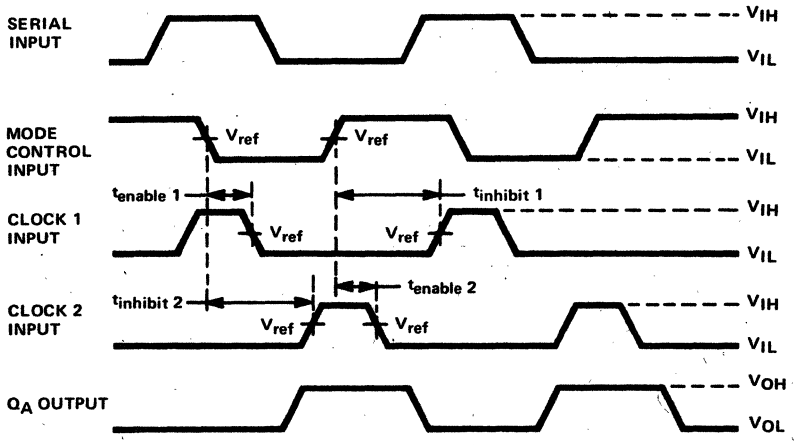
NOTES:

A. Input pulses are supplied by a generator having the following characteristics: $t_r \leq 10$ ns, $t_f \leq 10$ ns, and $Z_{out} \cong 50\Omega$. For the data pulse generator, PRR = 500kHz; for the clock pulse generator, PRR = 1MHz. When testing f_{max}, vary PRR. $t_{w(data)} \geq 20$ ns, $t_{w(clock)} \geq 15$ ns.

B. C_L includes probe and jig capacitance.

C. All diodes are 1N916 or 1N3064

D. $V_{ref} = 1.3V$.



VOLTAGE WAVEFORMS

FIGURE 2 – CLOCK ENABLE/INHIBIT TIMES

NOTES:

A. Input A is at a low level.

B. $V_{ref} = 1.3V$.

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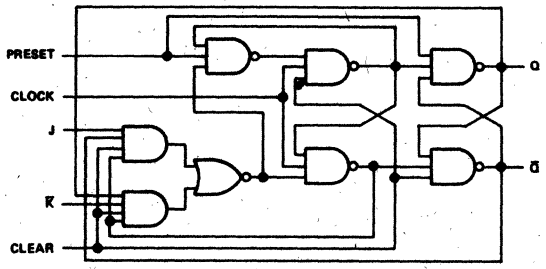
DESCRIPTION

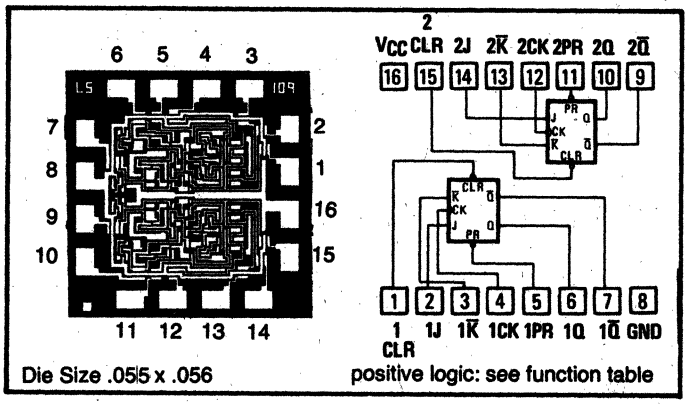
This monolithic dual J-$\overline{K}$ edge-triggered flip-flop features individual J, $\overline{K}$, clock, preset, and clear inputs. A low level at preset or clear sets or resets the outputs regardless of the levels of the other inputs. When preset and clear are inactive (high), data at the J and $\overline{K}$ inputs meeting the setup time requirements are transferred to the outputs on the positive-going edge of the clock pulse. Clock triggering occurs at a voltage level of the clock pulse and is not directly related to the transition time of the positive-going pulse. Following the hold time interval, data at the J and $\overline{K}$ inputs may be changed without affecting the levels at the outputs.

The J and K data inputs simplify hardware design as a D-type flip-flop can be implemented by simply tying the J and $\overline{K}$ inputs together.

LOGIC DIAGRAM (½)



PIN-OUT DIAGRAM



Die Size .055 x .056

positive logic: see function table

FUNCTION TABLE (EACH FLIP-FLOP)

INPUTS					OUTPUTS	
PRESET	CLEAR	CLOCK	J	$\overline{K}$	Q	$\overline{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	↑	L	L	L	H
H	H	↑	H	L	TOGGLE	
H	H	↑	L	H	Q_0	$\overline{Q}_0$
H	H	↑	H	H	H	L
H	H	L	X	X	Q_0	$\overline{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↑ = transition from low to high level
Q_0 = the level of Q before the indicated steady-state input conditions were established
TOGGLE: each output changes to the complement of its previous level on each ↑ clock transition.
*This configuration is nonstable; that is, it will not persist when preset and clear inputs return to their inactive (high) level.

Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
Normalized fan-out from each output, N	High logic level			20			20	
	Low logic level			10			20	
Clock frequency, f_{clock}		0		30	0		30	MHz
Width of clock pulse, $t_{w(clock)}$ (High)		17			17			ns
Width of preset pulse, $t_{w(preset)}$ (Low)		15			15			ns
Width of clear pulse, $t_{w(clear)}$ (Low)		15			15			ns
Input setup time t_{setup}		15			15			ns
Input hold time, t_{hold}		0			0			ns
Operating free-air temperature, T_A		−55		125	0		70	°C

t_{setup} is the minimum time required for the correct logic level to be present at the J or K input prior to the rising edge of the clock in order to be recognized and transferred to the outputs.

t_{hold} is the minimum time required for the logic level to be maintained at the J or K input after the clock transition in order to insure recognition. This device requires no hold time.

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Dual J-K Positive-Edge-Triggered Flip-Flop

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS			9LS/74LS			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=−18mA				−1.5			−1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=−400μA		2.5	3.4		2.7	3.4		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
			I_{OL}=8mA					0.35	0.5	
I_I	J or $\overline{K}$	V_{CC}=MAX, V_I=5.5V				0.1			0.1	mA
	clock or preset					0.2			0.2	
	Clear					0.4			0.4	
I_{IH}	J or $\overline{K}$	V_{CC}=MAX, V_I=2.7V				20			20	μA
	clock or preset					40			40	
	Clear					80			80	
I_{IL}	J or $\overline{K}$	V_{CC}=MAX, V_I=0.4V				−0.4			−0.4	mA
	clock or preset					−0.8			−0.8	
	Clear					−1.6			−1.6	
I_{OS}†		V_{CC}=MAX		−15		−100	−15		−100	mA
I_{CC}††		V_{CC}=MAX,			4	8		4	8	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
†† I_{CC} is measured with outputs open, clock grounded, and J, K, preset, and clear at 4.5V.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter		−55°C			+25°C			+125°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Figure A on page 2-147)											
f_{max}					30	45					MHz
t_{PLH}						10	15				ns
t_{PHL}	CK Low					12	18				ns
	CK High					16	24				
t_{PLH}						12	18				ns
t_{PHL}						14	22				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Figure A on page 2-147)											
f_{max}											
t_{PLH}											
t_{PHL}	CK Low										
	CK High										
t_{PLH}											
t_{PHL}											

t_{setup} is the minimum time required for the correct logic level to be present at the J or K input prior to the rising edge of the clock in order to be recognized and transferred to the outputs.

t_{hold} is the minimum time required for the logic level to be maintained at the J or K input after the clock transition in order to insure recognition. This device requires no hold time.

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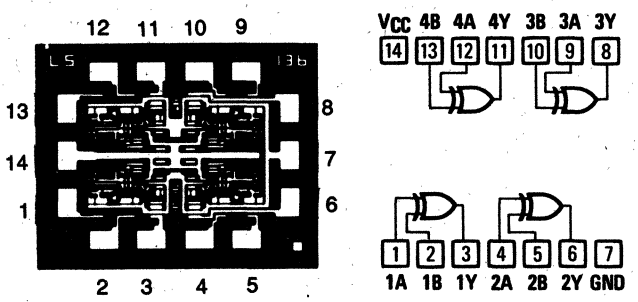
Quadruple 2-Input Exclusive-OR, -NOR Gates With Open-Collector Outputs

PIN-OUT AND LOGIC DIAGRAMS

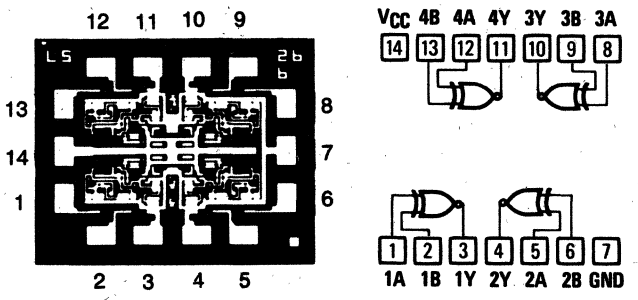
LS136
QUADRUPLE 2-INPUT EXCLUSIVE-OR WITH OPEN-COLLECTOR OUTPUTS



Die Size .045 x .056

positive logic: $Y = A \oplus B = \overline{A}B + A\overline{B}$

LS266
QUADRUPLE 2-INPUT EXCLUSIVE-NOR WITH OPEN COLLECTOR OUTPUTS



Die Size .045 x .056

positive logic: $Y = \overline{A \oplus B} = AB + \overline{A}\overline{B}$

Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output voltage, V_{OH}			5.5			5.5	V
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	−55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS			9LS/74LS			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=−18mA				−1.5			−1.5	V
I_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, V_{OH}=5.5V				100			100	μA
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
			I_{OL}=8mA					0.35	0.5	
I_I		V_{CC}=MAX, V_I=7V				0.2			0.2	mA
I_{IH}		V_{CC}=MAX, V_I=2.7V				40			40	μA
I_{IL}		V_{CC}=MAX, V_I=0.4V				−0.6			−0.6	mA
I_{CC}†	LS266	V_{CC}=MAX,			8	13		8	13	mA
	LS136				6.1	10		6.1	10	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†I_{CC} is measured with one input of each gate at 4.5V, the other inputs grounded, and the outputs open.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	From (input)	To (output)	−55°C			+25°C			+125°C			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Figure A on page 2-147)												
t_{PLH}	A or B	Other input low						23				ns
t_{PHL}								23				
t_{PLH}	A or B	Other input high						23				ns
t_{PHL}								23				

*t_{PLH} = propagation delay time, low-to-high level output.

t_{PHL} = propagation delay time, high-to-low level output.

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Decoders/Demultiplexers

LS138, LS139

FEATURES

- **LS138: 3-Line-to-8-Line Decoder**
  1-of-8 Demultiplexer
- **LS139: Dual 2-Line-to-4-Line Decoder**
  Dual 1-of-4 Demultiplexer
- **LS138 is expandable to 5-lines-to-32-lines decoder using 4 LS138's and one inverter.**

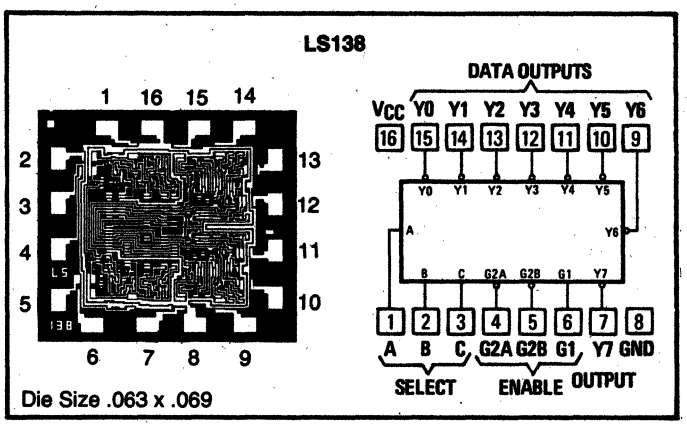
DESCRIPTION

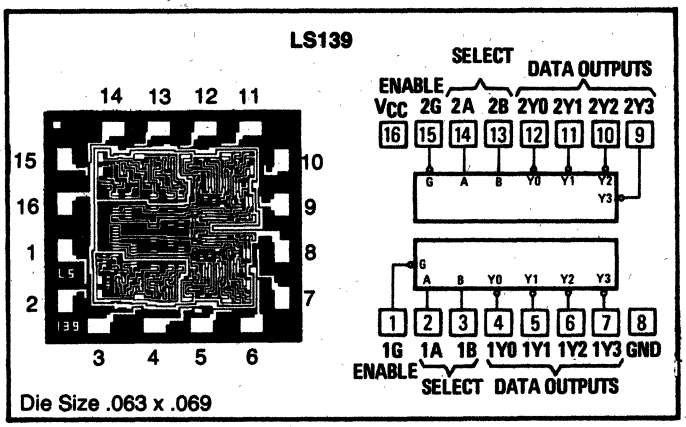
The LS138 decodes one-of-eight lines dependent on the conditions at the three binary select inputs and the three enable inputs. Two active-low and one active-high enable inputs reduce the need for external gates or inverters when expanding. A 24-line decoder can be implemented without external inverters and a 32-line decoder requires only one inverter. An enable input can be used as a data input for demultiplexing applications.

The LS139 comprises two individual two-line-to-four-line decoders in a single package. The active-low enable input can be used as a data line in demultiplexing applications.

These circuits are designed to be used in high-performance memory-decoding and data-routing applications requiring very short delay times.

PIN-OUT DIAGRAMS





LS138
FUNCTION TABLE

INPUTS					OUTPUTS							
ENABLE		SELECT										
G1	G2*	C	B	A	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
X	H	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	H	H	L	H	H	H	H	H	H
H	L	L	H	L	H	H	L	H	H	H	H	H
H	L	L	H	H	H	H	H	L	H	H	H	H
H	L	H	L	L	H	H	H	H	L	H	H	H
H	L	H	L	H	H	H	H	H	H	L	H	H
H	L	H	H	L	H	H	H	H	H	H	L	H
H	L	H	H	H	H	H	H	H	H	H	H	L

*G2 = G2A + G2B

H = high level, L = low level, X = don't care

LS139
FUNCTION TABLE (½)

INPUTS			OUTPUTS			
ENABLE	SELECT					
G	B	A	Y0	Y1	Y2	Y3
H	X	X	H	H	H	H
L	L	L	L	H	H	H
L	L	H	H	L	H	H
L	H	L	H	H	L	H
L	H	H	H	H	H	L

H = high level, L = low level, X = don't care

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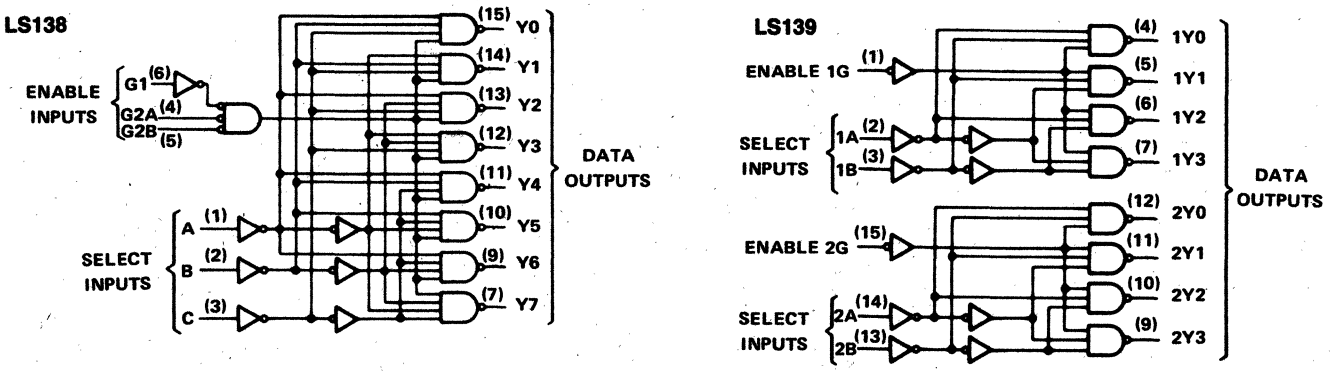
LOGIC DIAGRAMS



Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-400			-400	μA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-400μA		2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.36			-0.36	mA
I_{OS}†	V_{CC}=MAX		-15		-100	-15		-100	mA
I_{CC}	V_{CC}=MAX, Outputs enabled and open	LS138		6.3	10		6.3	10	mA
		LS139		6.8	11		6.8	11	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

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Decoders/Demultiplexers

LS138

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	Levels of Delay	From (Input)	To (output)	−55°C			+25°C			+125°C			Unit
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ													
t_{PLH}	2	Binary Select	Any		11	16		10	15		13	18	ns
t_{PHL}					17	24		17	24		21	27	ns
t_{PLH}	3				16	22		16	21		21	28	ns
t_{PHL}					22	30		21	28		24	32	ns
t_{PLH}	2	Enable	Any		11	16		10	15		13	18	ns
t_{PHL}					19	26		18	25		23	30	ns
t_{PLH}	3				16	22		16	22		21	27	ns
t_{PHL}					22	30		20	28		24	31	ns
Test Conditions: C_L = 50pF, R_L = 2kΩ													
t_{PLH}	2	Binary Select	Any		13	19		12	17		14	20	ns
t_{PHL}					23	31		22	29		26	33	ns
t_{PLH}	3				17	24		17	23		23	29	ns
t_{PHL}					26	35		25	32		28	36	ns
t_{PLH}	2	Enable	Any		11	16		12	18		15	20	ns
t_{PHL}					23	30		24	33		26	34	ns
t_{PLH}	3				18	24		18	23		24	30	ns
t_{PHL}					26	34		24	32		28	37	ns

LS139

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	Levels of Delay	From (Input)	To (output)	−55°C			+25°C			+125°C			Unit
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ													
t_{PLH}	2	Binary Select	Any					12	17				ns
t_{PHL}								12	17				ns
t_{PLH}	3							15	22				ns
t_{PHL}								17	25				ns
t_{PLH}	2	Enable	Any					11	15				ns
t_{PHL}								11	16				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ													
t_{PLH}	2	Binary Select	Any										ns
t_{PHL}													ns
t_{PLH}	3												ns
t_{PHL}													ns
t_{PLH}	2	Enable	Any										ns
t_{PHL}													ns

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FEATURES

- Select one of eight data sources
- Perform parallel-to-serial conversion
- LS151 has complementary outputs; LS152 has inverting output only
- LS151 has strobe input

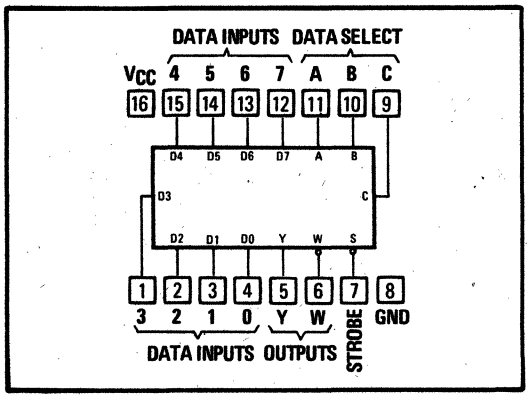
DESCRIPTION

These monolithic data selectors/multiplexers contain full on-chip binary decoding to select one-of-eight data sources. The LS151 has a strobe input which must be at a low logic level to enable the device. A high level at the strobe forces the W output high, and the Y output low.

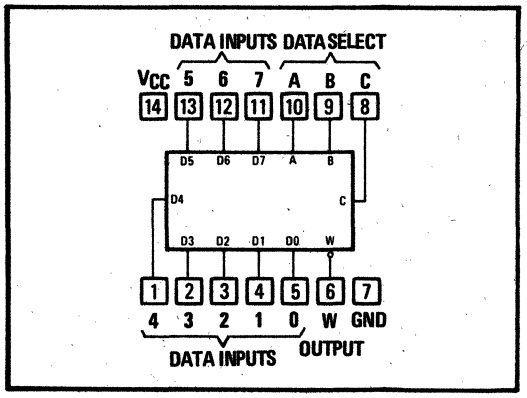
The LS151 features complementary W and Y outputs whereas the LS152 has an inverted (W) output only.

PIN-OUT DIAGRAMS

LS151



LS152



LS151 FUNCTION TABLE

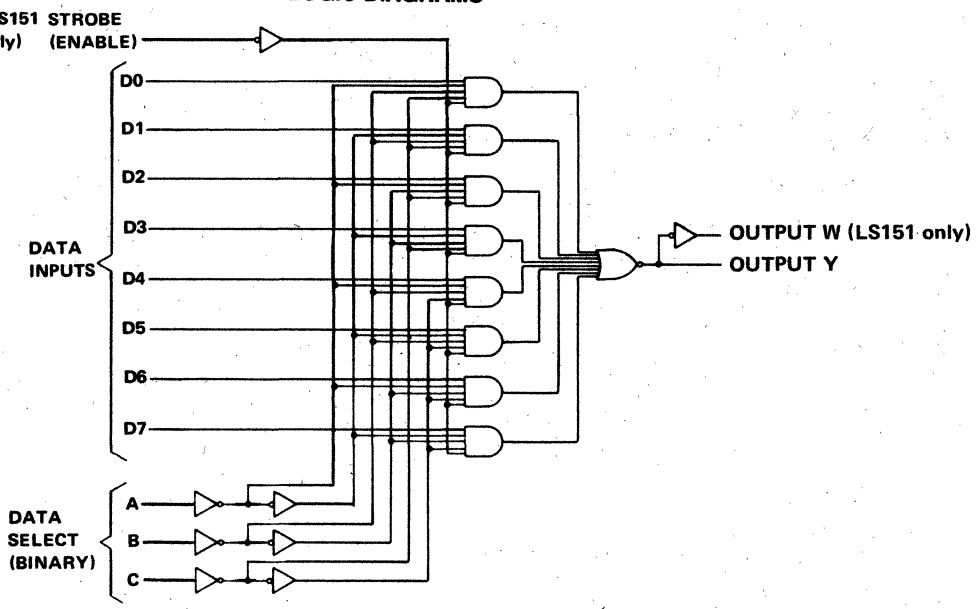
INPUTS				OUTPUTS	
SELECT			STROBE	Y	W
C	B	A	S		
X	X	X	H	L	H
L	L	L	L	D0	$\overline{D0}$
L	L	H	L	D1	$\overline{D1}$
L	H	L	L	D2	$\overline{D2}$
L	H	H	L	D3	$\overline{D3}$
H	L	L	L	D4	$\overline{D4}$
H	L	H	L	D5	$\overline{D5}$
H	H	L	L	D6	$\overline{D6}$
H	H	H	L	D7	$\overline{D7}$

LS152 FUNCTION TABLE

SELECT INPUTS			OUTPUT
C	B	A	W
L	L	L	$\overline{D0}$
L	L	H	$\overline{D1}$
L	H	L	$\overline{D2}$
L	H	H	$\overline{D3}$
H	L	L	$\overline{D4}$
H	L	H	$\overline{D5}$
H	H	L	$\overline{D6}$
H	H	H	$\overline{D7}$

H = high level, L = low level, X = don't care
D0, D1 . . . D7 = the level of the D respective input

LOGIC DIAGRAMS



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8-Line-To-1-Line Multiplexers

Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-400			-400	μA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max I_{OH}=-400μA		2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA					0.25	0.4	V
		I_{OL}=8mA		0.3	0.45		0.35	0.5	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.4			-0.4	mA
I_{OS}†	V_{CC}=MAX		-15		-100	-15		-100	mA
I_{CC}	V_{CC}=MAX, Outputs open, All inputs at 4.5V	LS151		6.0	10		6.0	10	mA
		LS152		5.6	9		5.6	9	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter¶	From (Input)	To (output)	-55°C			+25°C			+125°C			Unit
			Min	Typ	Max*	Min	Typ	Max*	Min	Typ	Max*	
Test Conditions: C_L = 15pF, R_L = 2kΩ												
t_{PLH}	A, B, or C (4 levels)	W (54LS151 only)						43				ns
t_{PHL}								30				
t_{PLH}	A, B, or C (3 levels)	Y						23				ns
t_{PHL}								32				
t_{PLH}	Strobe	W (54LS151 only)						42				ns
t_{PHL}								28				
t_{PLH}	Strobe	Y (54LS151 only)						24				ns
t_{PHL}								30				
t_{PLH}	Any D	W (54LS151 only)						32				ns
t_{PHL}								28				
t_{PLH}	Any D	Y						21				ns
t_{PHL}								20				

¶ t_{PLH} = Propagation delay time, low-to-high-level output
t_{PHL} = Propagation delay time, high-to-low-level output

*Tentative data, subject to change without notice

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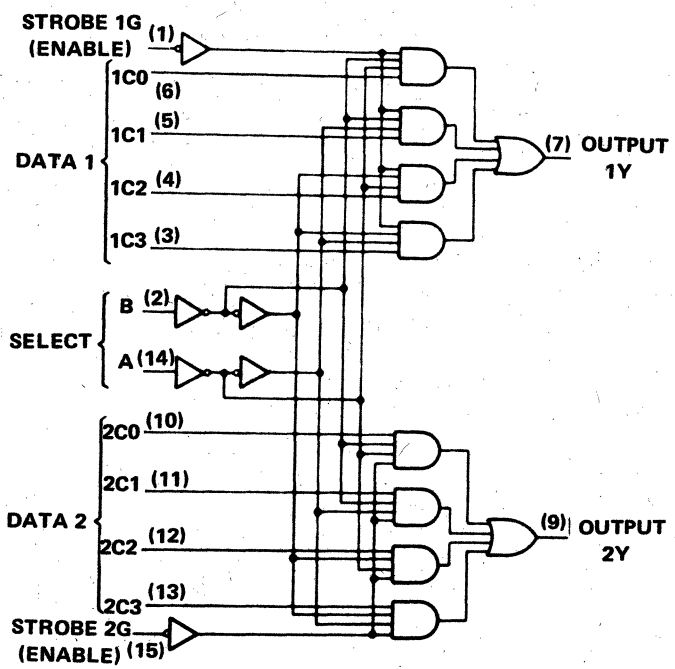
FEATURES

- Permits multiplexing from N lines to 1 line
- Performs parallel-to-serial conversion
- Strobe (Enable) line provided for cascading (N lines to n lines)
- Non-inverting

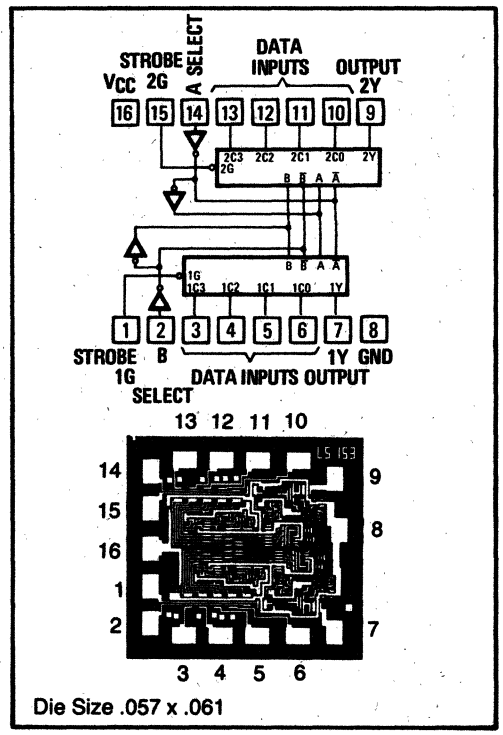
DESCRIPTION

The LS153 is a high speed Dual 4-Line-to-1-Line Multiplexer with common select inputs and separate strobe (enable) inputs for each half. Each half can select one bit of four and present it at the output in non-inverted form.

LOGIC DIAGRAM



PIN-OUT DIAGRAM



FUNCTION TABLE

SELECT INPUTS		DATA INPUTS				STROBE	OUTPUT
B	A	C0	C1	C2	C3	G	Y
X	X	X	X	X	X	H	L
L	L	L	X	X	X	L	L
L	L	H	X	X	X	L	H
L	H	X	L	X	X	L	L
L	H	X	H	X	X	L	H
H	L	X	X	L	X	L	L
H	L	X	X	H	X	L	H
H	H	X	X	X	L	L	L
H	H	X	X	X	H	L	H

Select inputs A and B are common to both sections.

H = high level, L = low level, X = don't care

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Dual 4-Line-To-1-Line Multiplexer

Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.5	V
High-level output current, I_{OH}			-400			-400	μA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-400μA		2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
I_I	V_{CC}=MAX, V_I=7.0V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.36			-0.36	mA
I_{OS}†	V_{CC}=MAX		-15		-100	-15		-100	mA
I_{CCL}††	V_{CC}=MAX			6.2	10		6.2	10	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
††I_{CCL} is measured with the outputs open and all inputs grounded.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter ¶	From (input)	To (output)	-55°C			+25°C			+125°C			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ												
t_{PLH}	Data	Y		8	13		8	13		11	16	ns
t_{PHL}	Data	Y		13	18		14	18		17	22	ns
t_{PLH}	Select	Y		15	21		17	22		22	28	ns
t_{PHL}	Select	Y		17	23		16	21		21	26	ns
t_{PLH}	Strobe	Y		14	20		16	21		21	26	ns
t_{PHL}	Strobe	Y		17	23		16	21		20	25	ns
Test Conditions: C_L = 50pF, R_L = 2kΩ												
t_{PLH}	Data	Y		10	15		10	15		15	22	ns
t_{PHL}	Data	Y		17	23		17	22		22	27	ns
t_{PLH}	Select	Y		18	24		19	24		25	30	ns
t_{PHL}	Select	Y		22	27		19	25		24	30	ns
t_{PLH}	Strobe	Y		17	23		18	23		23	28	ns
t_{PHL}	Strobe	Y		21	27		20	24		23	28	ns

¶ t_{PLH} ≡ propagation delay time, low-to-high-level output.
t_{PHL} ≡ propagation delay time, high-to-low-level output.

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Dual 2-Line-To-4-Line Decoders/Demultiplexers

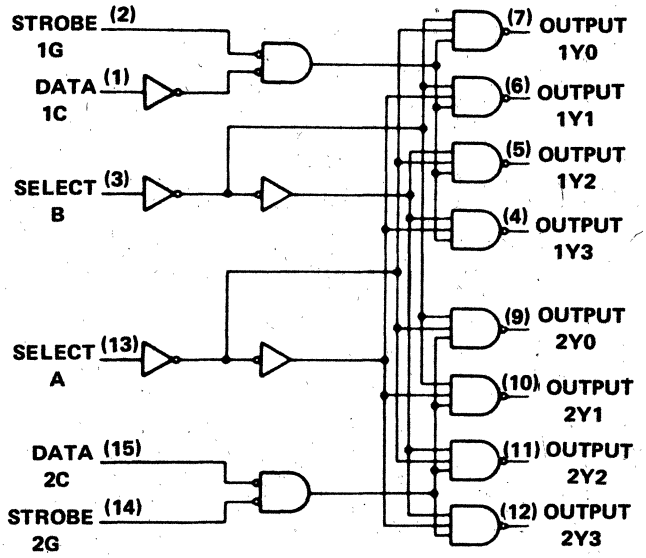
FEATURES

- LS156 has open-collector outputs
- Applications:
  - Dual 2-Line-to-4-Line Decoder
  - Dual 1-Line-to-4-Line Demultiplexer
  - 3-Line-to-8-Line Decoder
  - 1-Line-to-8-Line Demultiplexer

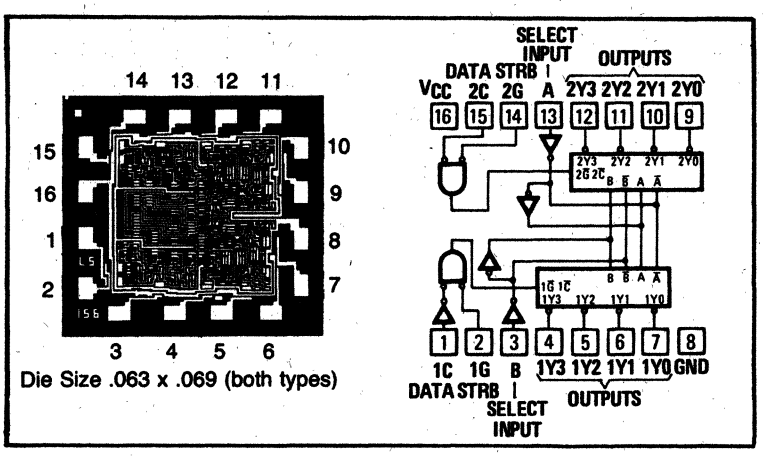
DESCRIPTION

These circuits feature dual 1-line-to-4-line demultiplexers with individual strobes and common binary-address inputs in a single 16-pin package. When both sections are enabled by the strobes, the common binary-address inputs sequentially select and route associated input data to the appropriate output of each section. The individual strobes permit activating or inhibiting each of the 4-bit sections as desired. Data applied to input 1C is inverted at its outputs and data applied at 2C is not inverted through its outputs. The inverter following the 1C data input permits use as a 3-to-8-line decoder or 1-to-8-line demultiplexer without external gating. Input clamping diodes are provided on all of these circuits to minimize transmission-line effects and simplify system design.

LOGIC DIAGRAM



PIN-OUT DIAGRAM



FUNCTION TABLES
2-LINE-TO-4-LINE DECODER
OR 1-LINE-TO-4-LINE DEMULTIPLEXER

INPUTS				OUTPUTS			
SELECT		STROBE	DATA				
B	A	1G	1C	1Y0	1Y1	1Y2	1Y3
X	X	H	X	H	H	H	H
L	L	L	H	L	H	H	H
L	H	L	H	H	L	H	H
H	L	L	H	H	H	L	H
H	H	L	H	H	H	H	L
X	X	X	L	H	H	H	H

INPUTS				OUTPUTS			
SELECT		STROBE	DATA				
B	A	2G	2C	2Y0	2Y1	2Y2	2Y3
X	X	H	X	H	H	H	H
L	L	L	L	L	H	H	H
L	H	L	L	H	L	H	H
H	L	L	L	H	H	L	H
H	H	L	L	H	H	H	L
X	X	X	H	H	H	H	H

FUNCTION TABLE
3-LINE-TO-8-LINE DECODER
OR 1-LINE-TO-8-LINE DEMULTIPLEXER

INPUTS				OUTPUTS							
SELECT			STROBE OR DATA	(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
C†	B	A	G‡	2Y0	2Y1	2Y2	2Y3	1Y0	1Y1	1Y2	1Y3
X	X	X	H	H	H	H	H	H	H	H	H
L	L	L	L	L	H	H	H	H	H	H	H
L	L	H	L	H	L	H	H	H	H	H	H
L	H	L	L	H	H	L	H	H	H	H	H
L	H	H	L	H	H	H	L	H	H	H	H
H	L	L	L	H	H	H	H	L	H	H	H
H	L	H	L	H	H	H	H	H	L	H	H
H	H	L	L	H	H	H	H	H	H	L	H
H	H	H	L	H	H	H	H	H	H	H	L

†C = inputs 1C and 2C connected together
‡G = inputs 1G and 2G connected together
H = high level, L = low level, X = don't care

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Dual 2-Line-To-4-Line Decoders/Demultiplexers

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

	9LS/54LS			9LS/74LS			Unit
	Min	Typ**	Max	Min	Typ**	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-400			-400	μA
Output voltage, V_{OH} (LS156 only)			5.5			5.5	V
Low-level output, I_{OL}			4			8	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-400μA		2.5	3.4		2.7	3.4		V
I_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, V_{OH}=5.5V (LS156 only)				100			100	μA
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.36			-0.36	mA
I_{OS}†	V_{CC}=MAX		-15		-100	-15		-100	mA
I_{CC}††	V_{CC}=MAX			6.1	10		6.1	10	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
††I_{CC} is measured with outputs open, A, B, and 1C inputs at 4.5V, and 2C, 1G, and 2G inputs grounded.

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LS155

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter ¶	Levels of Logic	From (Input)	To (output)	−55°C			+25°C			+125°C			Unit
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ													
t_{PLH}	2	2C, 1G, or 2G	Y					11	15				ns
t_{PHL}	2	2C, 1G, or 2G	Y					13	20				ns
t_{PLH}	3	A or B	Y					14	18				ns
t_{PHL}	3	A or B	Y					18	27				ns
t_{PLH}	3	1C	Y					13	18				ns
t_{PHL}	3	1C	Y					16	24				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ													
t_{PLH}	2	2C, 1G, or 2G	Y										ns
t_{PHL}	2	2C, 1G, or 2G	Y										ns
t_{PLH}	3	A or B	Y										ns
t_{PHL}	3	A or B	Y										ns
t_{PLH}	3	1C	Y										ns
t_{PHL}	3	1C	Y										ns

¶ t_{PLH} = Propagation delay time, low-to-high-level output
t_{PHL} = Propagation delay time, high-to-low-level output.

LS156

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter ¶	Levels of Logic	From (Input)	To (output)	−55°C			+25°C			+125°C			Unit
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ													
t_{PLH}	2	2C, 1G, or 2G	Y					22	30				ns
t_{PHL}	2	2C, 1G, or 2G	Y					16	24				ns
t_{PLH}	3	A or B	Y					27	37				ns
t_{PHL}	3	A or B	Y					22	30				ns
t_{PLH}	3	1C	Y					25	34				ns
t_{PHL}	3	1C	Y					23	31				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ													
t_{PLH}	2	2C, 1G, or 2G	Y										ns
t_{PHL}	2	2C, 1G, or 2G	Y										ns
t_{PLH}	3	A or B	Y										ns
t_{PHL}	3	A or B	Y										ns
t_{PLH}	3	1C	Y										ns
t_{PHL}	3	1C	Y										ns

¶ t_{PLH} = Propagation delay time, low-to-high-level output.
t_{PHL} = Propagation delay time, high-to-low-level output.

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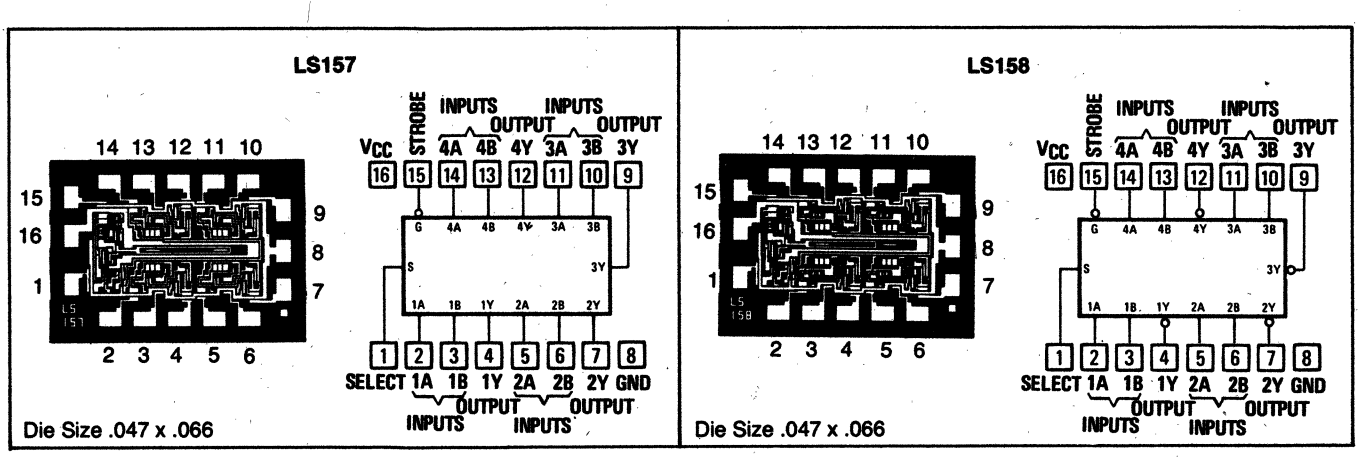
Quadruple 2-Line-To-1 Line Multiplexers

LS157 LS158

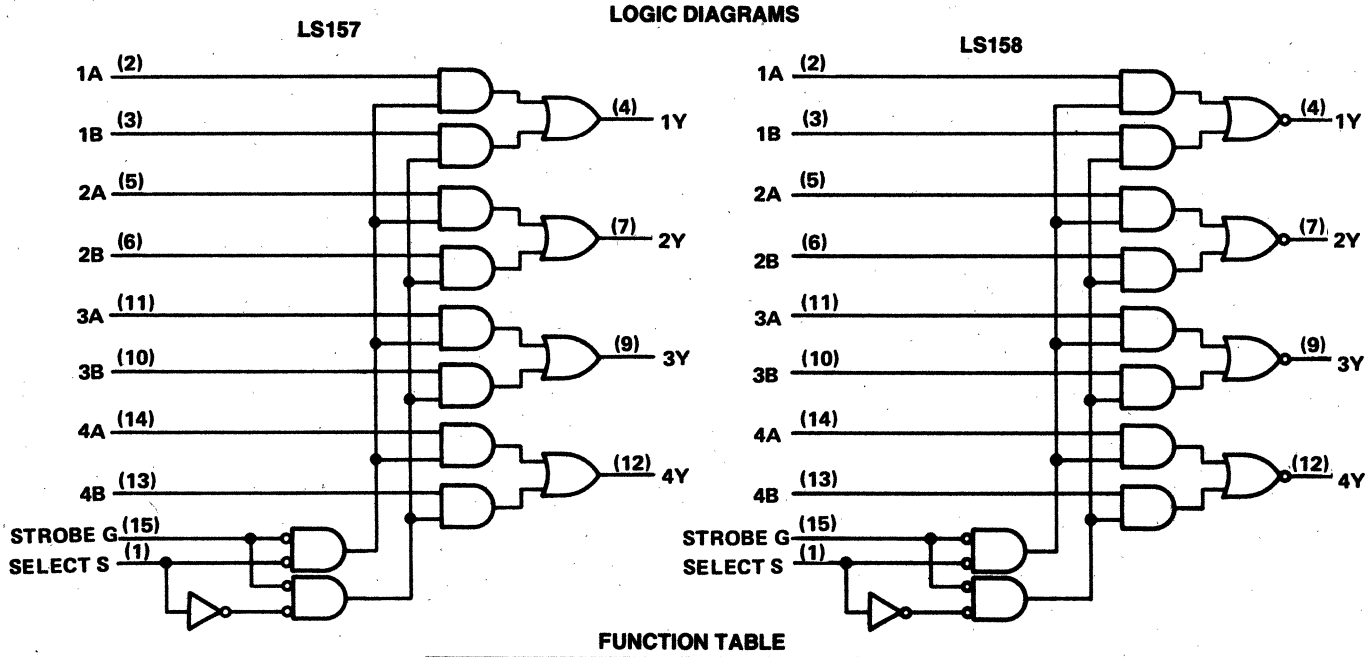
DESCRIPTION

These data selectors/multiplexers select a 4-bit word from one of two sources and present it at the four outputs. The LS157 presents true data; the LS158 presents inverted data.

PIN-OUT DIAGRAMS



LOGIC DIAGRAMS



FUNCTION TABLE

INPUTS				OUTPUT Y	
STROBE	SELECT	A	B	54LS157	54LS158
H	X	X	X	L	H
L	L	L	X	L	H
L	L	H	X	H	L
L	H	X	L	L	H
L	H	X	H	H	L

H = high level, L = low level, X = don't care
Low level at S selects A inputs
High level at S selects B inputs
Strobe is active low

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Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-400			-400	μA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS			9LS/74LS			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=MAX, I_{OH}=-400μA		2.5	3.4		2.7	3.4		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=MAX	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
			I_{OL}=8mA					0.35	0.5	
I_I	S or G input	V_{CC}=MAX, V_I=7V				0.2			0.2	mA
	A or B input					0.1			0.1	
I_{IH}	S or G input	V_{CC}=MAX, V_I=2.7V				40			40	μA
	A or B input					20			20	
I_{IL}	S or G input	V_{CC}=MAX, V_I=0.4V				-0.8			-0.8	mA
	A or B input					-0.4			-0.4	
I_{OS}†		V_{CC}=MAX		-15		-100	-15		-100	mA
I_{CC}††		V_{CC}=MAX,	LS157		9.7	16		9.7	16	mA
			LS158		4.8	8		4.8	8	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
††I_{CC} is measured with 4.5V applied to all inputs and all outpus open.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter ¶		From (input)	To (output)	-55°C			+25°C			+125°C			Unit
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ													
t_{PLH}	LS157	Data						5	10				ns
t_{PHL}								7	14				
t_{PLH}	LS158	Data						7	13				ns
t_{PHL}								5	10				
t_{PLH}	LS157	Strobe						13	23				ns
t_{PHL}								8	16				
t_{PLH}	LS158	Strobe						8	18				ns
t_{PHL}								12	22				
t_{PLH}	LS157	Select						10	20				ns
t_{PHL}								11	20				
t_{PLH}	LS158	Select						11	20				ns
t_{PHL}								10	20				

¶ t_{PLH} = Propagation delay time, low-to-high-level output
t_{PHL} = Propagation delay time, high-to-low-level output.

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Synchronous BCD Decade Counters — LS160 LS162

Synchronous 4-Bit Binary Counters — LS161 LS163

FEATURES

- 4-bit synchronous counters
- Synchronously programmable
- Internal look-ahead counting
- Carry output for n-bit cascading
- Synchronous or asynchronous clear
- Advanced low-power Schottky technology
- 100% reliability assurance testing in compliance with MIL-STD-883

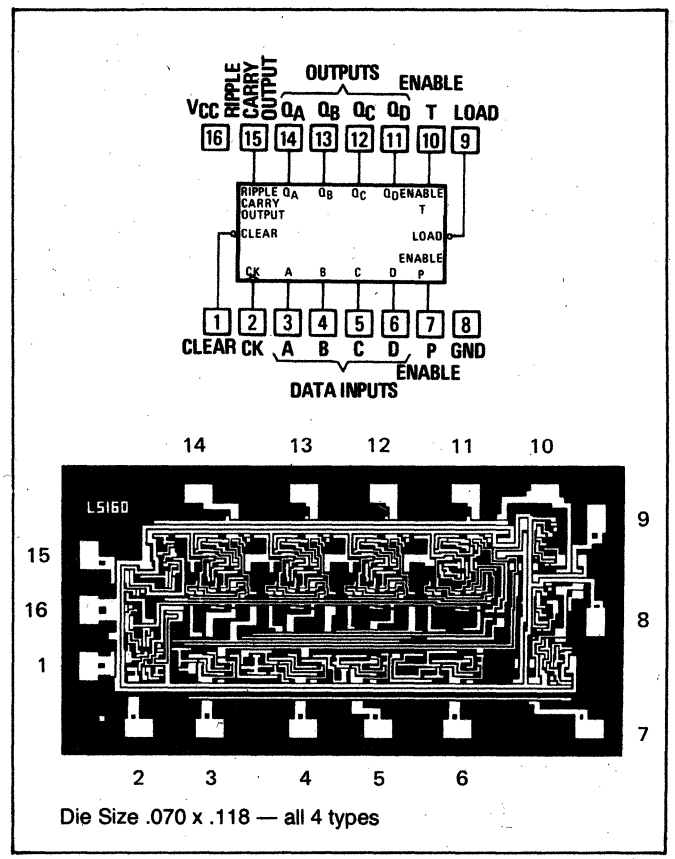
DESCRIPTION

The LS160, LS161, LS162 and LS163 synchronous, presettable counts have internal look-ahead carry and ripple carry output for high-speed counting applications. The LS160 and LS162 are decade counters and the LS161 and LS163 are 4-bit binary counters. Counting or loading occurs on the positive transition of the clock pulse. A LOW level on the load input causes the data on the A, B, C and D inputs to be shifted to the appropriate Q outputs on the next positive clock transition.

The LS160 and LS161 feature an asynchronous clear. A LOW level at the clear input sets the Q outputs LOW regardless of the other inputs. The LS162 and LS163 have a synchronous clear. A LOW level at the clear input sets the Q outputs LOW after the next positive clock transition regardless of the enable inputs.

Both count-enable inputs P and T must be HIGH to count. Count enable T is included in the ripple carry output gate for cascading connection.

PIN-OUT DIAGRAM



Die Size .070 x .118 — all 4 types

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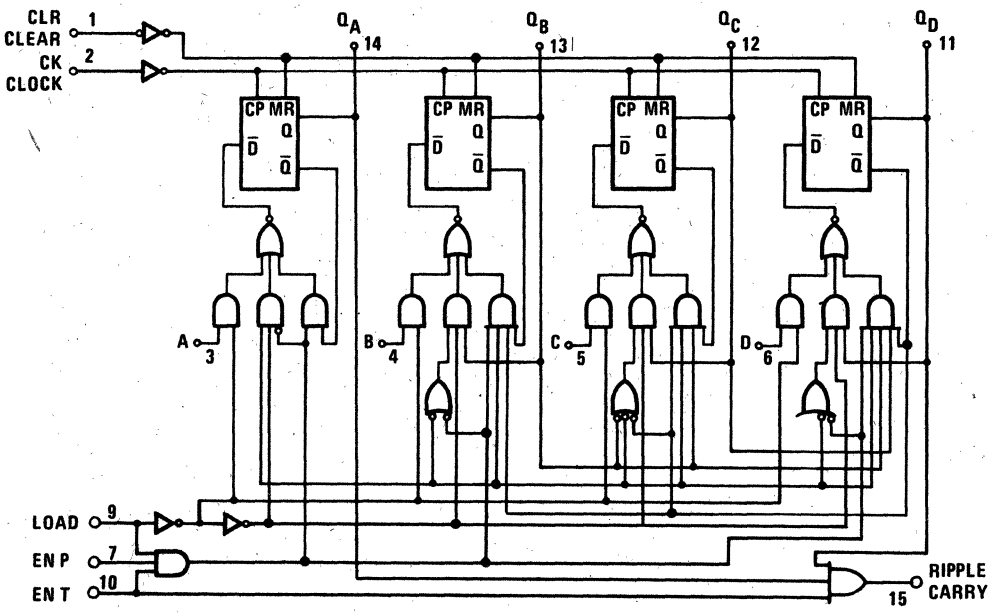
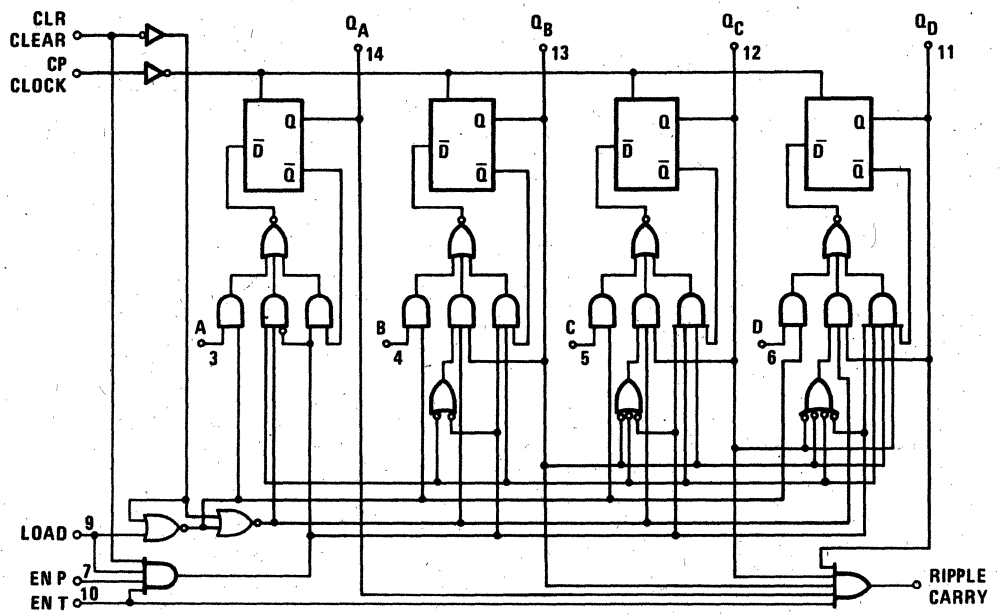
LOGIC DIAGRAMS

LS160 Synchronous Decade Counter



LS162 synchronous decade counters are similar; however, the clear is synchronous as shown for the LS163 binary counters.

LS163 SYNCHRONOUS BINARY COUNTER



LS161 synchronous binary counters are similar; however, the clear is asynchronous as shown for the LS160 decade counters.

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Synchronous BCD Decade Counters — LS160 LS162
Synchronous 4-Bit Binary Counters — LS161 LS163

Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5.0	5.25	V
High-level output current, I_{OH}				−400			−400	μA
Low-level output current, I_{OL}				4			8	mA
Clock frequency, f_{clock}		0		25	0		25	MHz
Width of clock pulse, $t_{w(clock)}$		25			25			ns
Width of clear pulse, $t_{w(clear)}$		20			20			ns
Setup time, t_{setup} (see Figures 1 and 2)	Data inputs A, B, C, D	0			0			ns
	Enable P or T	20			20			
	Load	20			20			
	Clear◇	20			20			
Hold time, t_{hold}	Data inputs A, B, C, D	25¶			25			ns
	Other inputs	10¶			10			
Operating free-air temperature, T_A		−55		125	0		70	°C

◇This applies only for LS162 and LS163, which have synchronous clear inputs.

¶ The minimum hold time is as specified or as long as the clock input takes to rise from 0.8 V to 2 V, whichever is longer.

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS			9LS/74LS			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=−18mA				−1.5			−1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=−400μA		2.5	3.4		2.7	3.4		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max,	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
			I_{OL}=8mA					0.35	0.5	
I_I	Data or enable P	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
	Load, clock, or enable T					0.2			0.2	
	Clear (LS160,161)					0.1			0.1	
	Clear (LS162,163)					0.2			0.2	
I_{IH}	Data or enable P	V_{CC}=MAX, V_I=2.7V				20			20	μA
	Load, clock, or enable T					40			40	
	Clear (LS160,161)					20			20	
	Clear (LS162,163)					40			40	
I_{IL}	Data or enable P	V_{CC}=MAX, V_I=0.4V				−0.4			−0.4	mA
	Load, clock, or enable T					−0.8			−0.8	
	Clear(LS160,161)					−0.4			−0.4	
	Clear(LS162,163)					−0.8			−0.8	
I_{OS}†		V_{CC}=MAX		−15		−100	−15		−100	mA
I_{CCH}		V_{CC}=MAX, See Note 1			18	31		18	31	mA
I_{CCL}		V_{CC}=MAX, See Note 2			19	32		19	32	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

NOTES:

1. I_{CCH} is measured with the load input high, then again with the load input low, with all other inputs high and all outputs open.
2. I_{CCL} is measured with the clock input high, then again with the clock input low, with all other inputs low and all outputs open.

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Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	From (Input)	To (output)	−55°C			+25°C			+125°C			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. 1 and 2 and Notes 3 and 4)												
f_{max}						30	40					MHz
t_{PLH}	Clock	Ripple carry					25	35				ns
t_{PHL}							20	35				
t_{PLH}	Clock (load input high)	Any Q					10	18				ns
t_{PHL}							15	20				
t_{PLH}	Clock (load input low)	Any Q					10	18				ns
t_{PHL}							14	20				
t_{PLH}	Enable T	Ripple carry					15	20				ns
t_{PHL}							9	14				
t_{PHL}	Clear	Any Q					14	28				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. 1 and 2 and Notes 3 and 4)												
f_{max}												MHz
t_{PLH}	Clock	Ripple carry										ns
t_{PHL}												
t_{PLH}	Clock (load input high)	Any Q										ns
t_{PHL}												
t_{PLH}	Clock (load input low)	Any Q										ns
t_{PHL}												
t_{PLH}	Enable T	Ripple carry										ns
t_{PHL}												
t_{PHL}	Clear	Any Q										ns

¶ f_{max} = Maximum clock frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

NOTES:
3. Load circuit is shown on page 2-147.
4. Propagation delay for clearing is measured from the clear input for the LS160 and LS161 or from the clock input transition for the LS162 and LS163.

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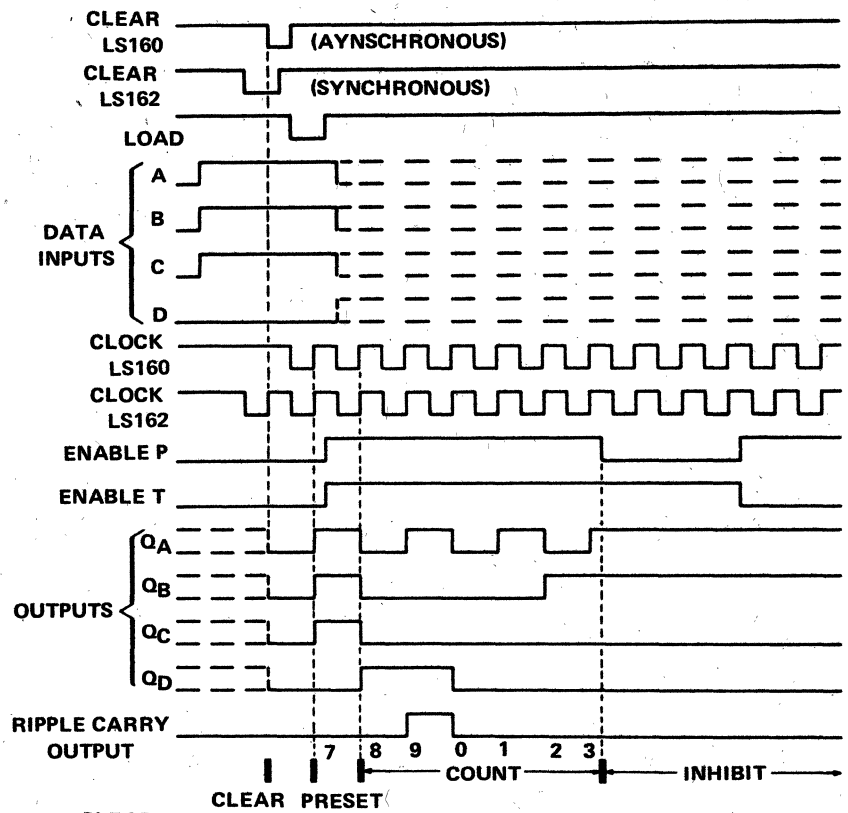
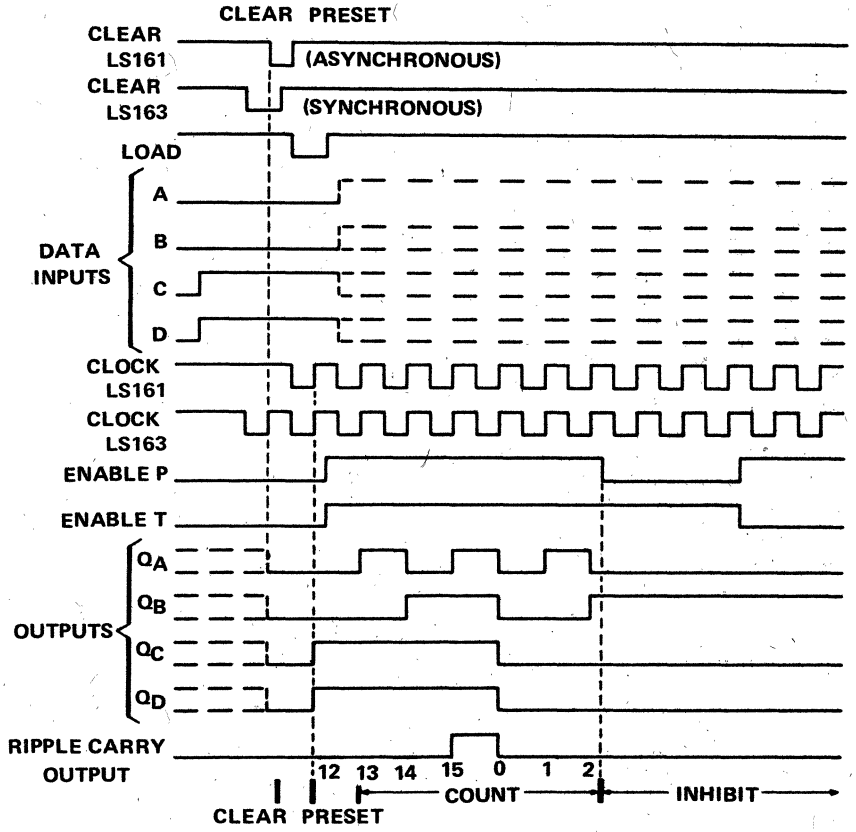
Synchronous BCD Decade Counters — LS160 LS162
Synchronous 4-Bit Binary Counters — LS161 LS163

TYPICAL CLEAR, PRESET, COUNT, AND INHIBIT SEQUENCES



LS160, LS162

Illustrated below is the following sequence:
1. Clear outputs to zero
2. Preset to BCD seven
3. Count to eight, nine, zero, one, two, and three
4. Inhibit



LS161, LS163

Illustrated below is the following sequence:
1. Clear outputs to zero
2. Preset to binary twelve
3. Count to thirteen; fourteen fifteen, zero, one, and two
4. Inhibit

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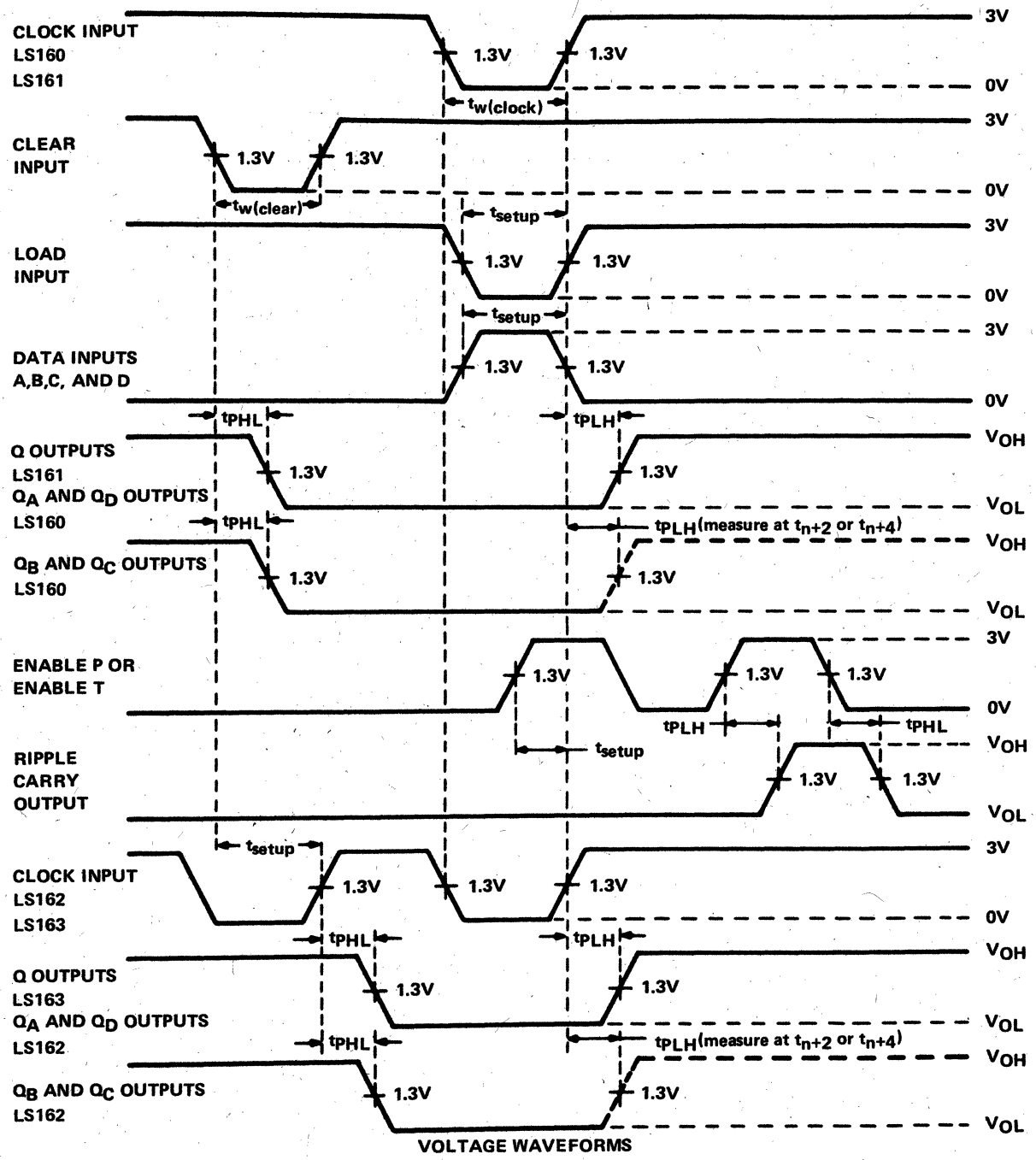
FIGURE 1

PARAMETER MEASUREMENT INFORMATION



VOLTAGE WAVEFORMS

NOTES:

A. The input pulses are supplied by generators having the following characteristics: PRR ⩽ 1 MHz, duty cycle ⩽ 50%, $Z_{out} \approx 50\,\Omega$; $t_r \leqslant 15$ ns, $t_f \leqslant 6$ ns.

B. Enable P and enable T setup times are measured at $t_n = 0$.

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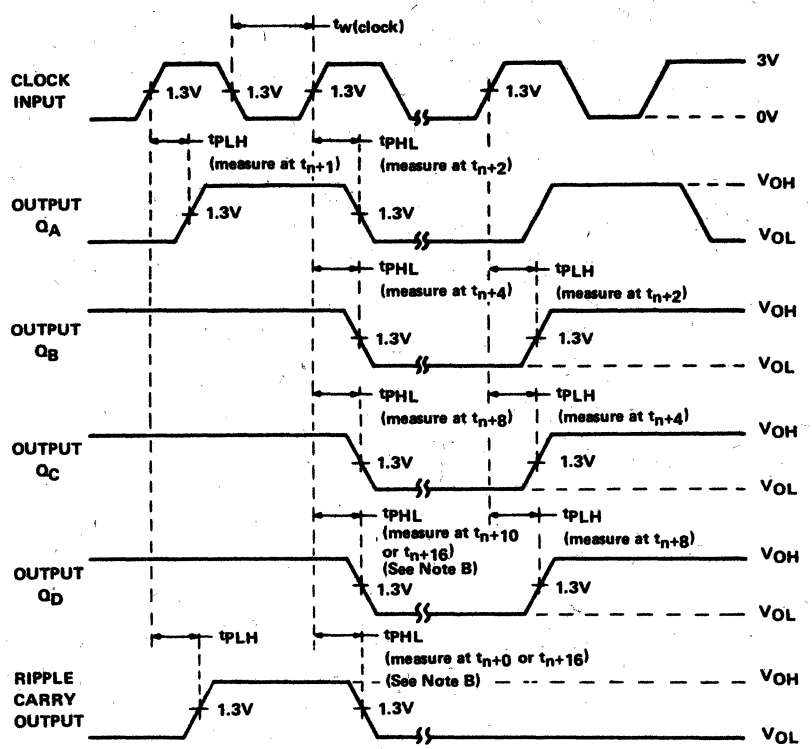
Synchronous BCD Decade Counters — LS160 LS162
Synchronous 4-Bit Binary Counters — LS161 LS163

FIGURE 2 **PARAMETER MEASUREMENT INFORMATION**



VOLTAGE WAVEFORMS

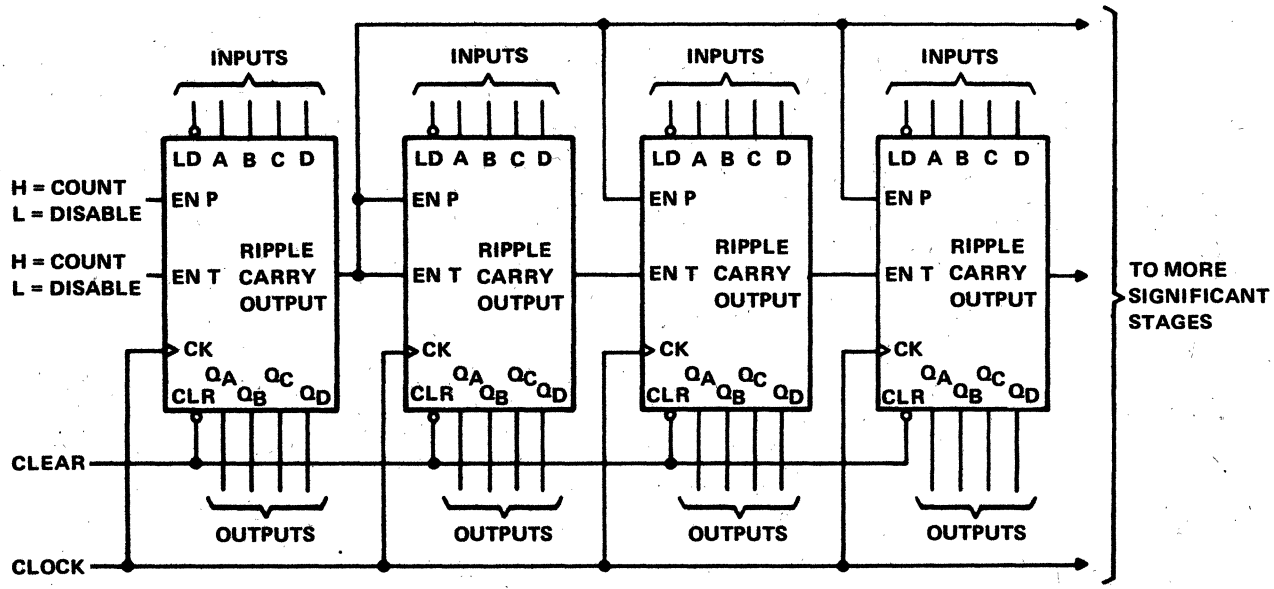
NOTES:

A. The input pulses are supplied by a generator having the following characteristics: PRR ≤ 1 MHz, duty cycle ≤ 50%, $Z_{out} \approx 50\Omega$: $t_r \leq 15$ ns, $t_f \leq 6$ ns. Vary PRR to measure f_{max}.

B. Outputs Q_d and carry are tested at t_{n+10} LS160, LS162, and at t_{n+16} for LS161, LS163 where t_n is the bit time when all outputs are low.

TYPICAL APPLICATION DATA
N-BIT SYNCHRONOUS COUNTERS

This application demonstrates how the look-ahead carry circuit can be used to implement a high-speed n-bit counter. The LS160 or LS162 will count in BCD and the LS163 will count in binary. Virtually any count mode (modulo-N, N_1-to N_2, N_1-to-maximum) can be used with this fast look-ahead circuit.



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FEATURES

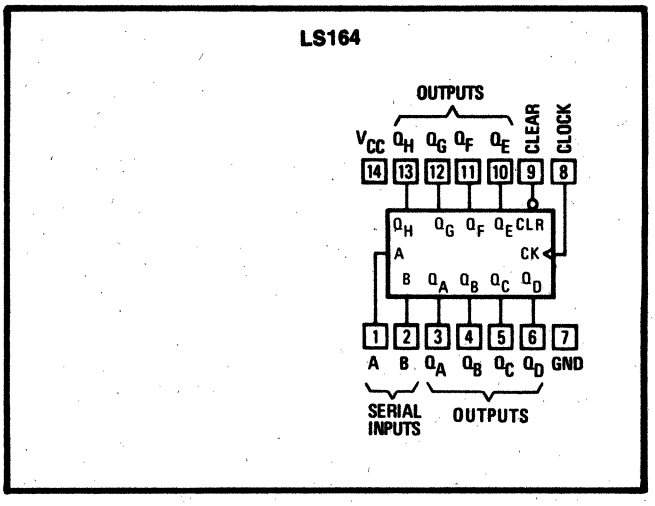
- Gated (Enable/Disable) Serial Inputs
- Fully Buffered Clock and Serial Inputs
- Asynchronous Clear

DESCRIPTION

These 8-bit shift registers feature gated serial inputs and an asynchronous clear. The gated serial inputs (A and B) permit complete control over incoming data as a low at either (or both) input(s) inhibits entry of the new data and resets the first flip-flop to the low level at the next clock pulse. A high-level input enables the other input which will then determine the state of the first flip-flop. Data at the serial inputs may be changed while the clock is high or low, but only information meeting the setup requirements will be entered. Clocking occurs on the low-to-high-level transition of the clock input. All inputs are diode-clamped to minimize transmission-line effects.

9LS/54LS devices are characterized for operation over the full military temperature range of −55°C to 125°C; 9LS/74LS devices are characterized for operation from 0°C to 70°C.

PIN-OUT DIAGRAM



FUNCTION TABLES

INPUTS				OUTPUTS		
CLEAR	CLOCK	A	B	Q_A	$Q_B \ldots Q_H$	
L	X	X	X	L	L	L
H	L	X	X	Q_{A0}	Q_{B0}	Q_{H0}
H	↑	H	H	H	Q_{An}	Q_{Gn}
H	↑	L	X	L	Q_{An}	Q_{Gn}
H	↑	X	L	L	Q_{An}	Q_{Gn}

H = high level (steady state), L = low level (steady state)

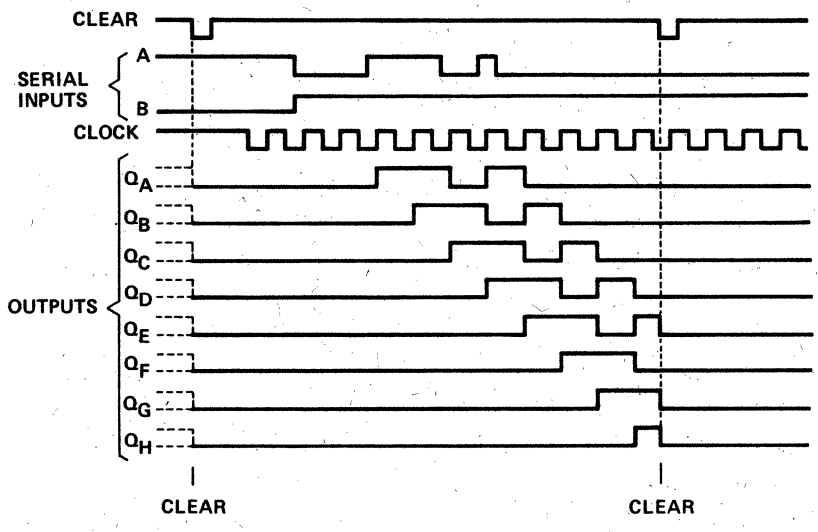
X = irrelevant (any input, including transitions)

↑ = transition from low to high level.

Q_{A0}, Q_{B0}, Q_{H0} = the level of Q_A, Q_B or Q_H, respectively, before the indicated steady state input conditions were established.

Q_{An}, Q_{Gn} = the level of Q_A or Q_G before the most recent ↑ transition of the clock; indicates a one-bit shift.

TYPICAL CLEAR, SHIFT, AND CLEAR SEQUENCES



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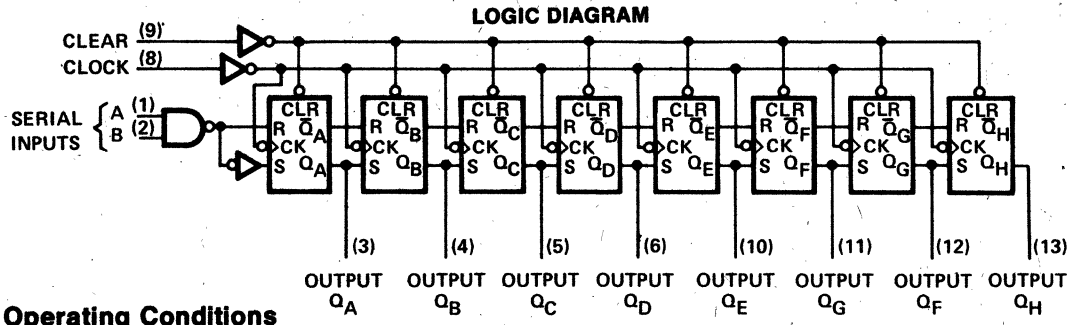
8-Bit Parallel-Out Serial Shift Registers

LS164

LOGIC DIAGRAM



Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			–400			–400	μA
Low-level output current, I_{OL}			4			8	mA
Clock frequency, f_{clock}	0		25	0		25	MHz
Width of clock or clear input pulse, t_w	20			20			ns
Data setup time, t_{setup} (see Figure 1)	15			15			ns
Data hold time, t_{hold} (see Figure 1)	5			5			ns
Operating free-air temperature, T_A	–55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=–18mA				–1.5			–1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=–400μA		2.5	3.5		2.7	3.5		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				–0.4			–0.4	mA
I_{OS}†	V_{CC}=MAX		–6		–40	–5		–42	mA
I_{CC}††	V_{CC}=MAX			16	27		16	27	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
††I_{CC} is measured with outputs open, serial inputs grounded, the clock input at 2.4V, and a momentary ground, then 4.5V applied to clear.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	–55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. 1)										
f_{max}				25	36					MHz
t_{PHL}					24	36				ns
t_{PLH}					17	27				ns
t_{PHL}					21	32				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. 1)										
f_{max}										
t_{PHL}										
t_{PLH}										
t_{PHL}										

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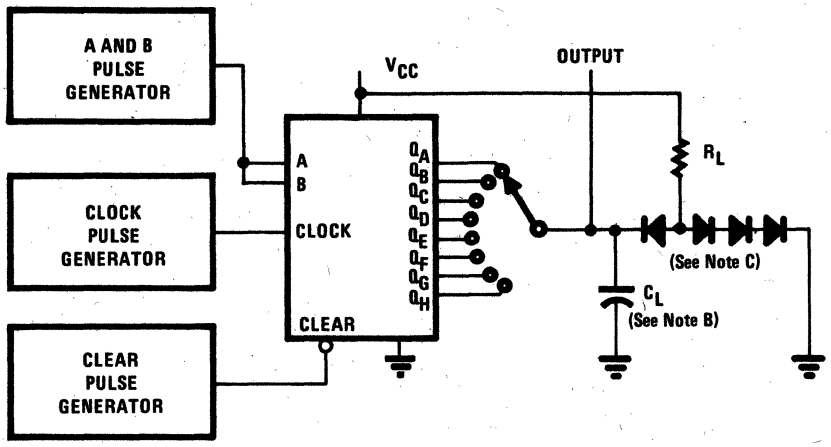
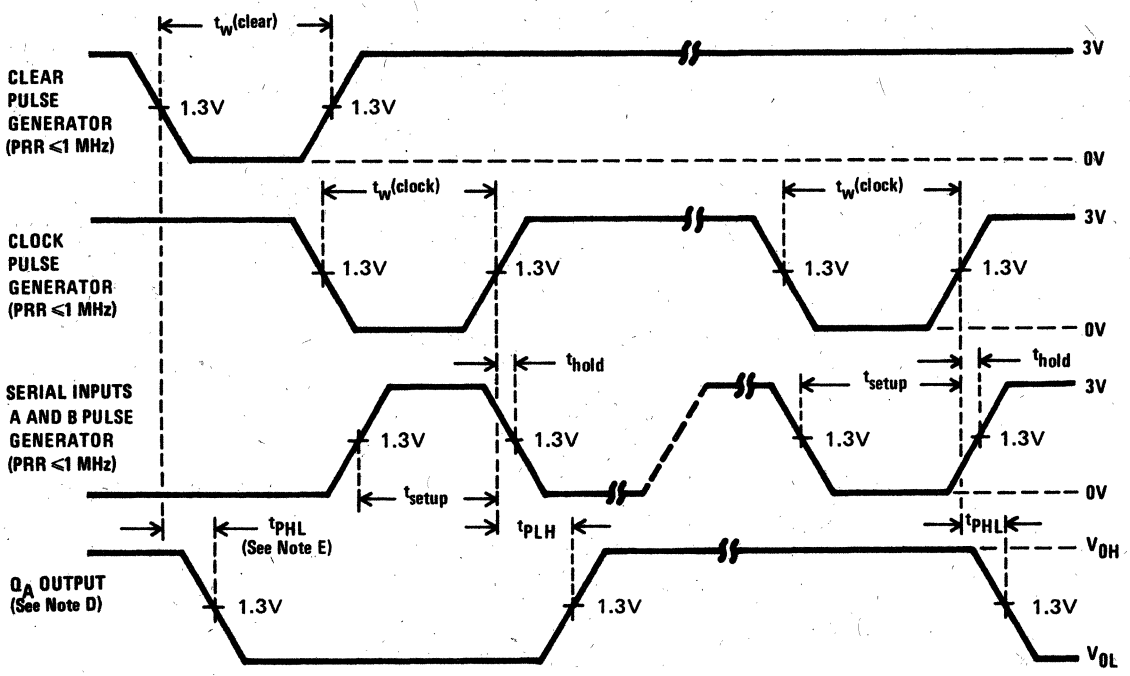
PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES: A. The pulse generators have the following characteristics: duty cycle ≤ 50%, $Z_{out} \approx 50\Omega$; for 164 and L164, $t_r \leq 10$ ns, $t_f \leq 10$ ns, and for LS164, $t_r \leq 15$ ns, $t_f \leq 6$ ns.

B. C_L includes probe and jig capacitance.

C. All diodes are 1N3064 or 1N916.

D. Q_A output is illustrated. Relationship of serial input A and B data to other Q outputs is illustrated in the typical shift sequence.

E. Outputs are set to the high level prior to the measurement of t_{PHL} from the clear input.

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Hex D-Type Flip-Flops With Clear — LS174

Quadruple D-Type Flip-Flops With Clear — LS175

FEATURES

- Positive edge-triggered common clock
- Asynchronous common reset
- Clock-to-output delays of 14 ns

DESCRIPTION

The LS174 is a six-bit register with single-rail outputs and the LS175 is a four-bit register with complementary outputs. Both consist of D-type flip-flops with a buffered common clock and an asynchronous, active-Low buffered clear.

Information at the D inputs meeting the setup time requirements is transferred to the Q outputs on the positive-going edge of the clock pulse. Clock triggering occurs at a particular voltage level and is not directly related to the transition time of the positive-going pulse. When the clock input is at either the high or low level, the D input signal has no effect at the output.

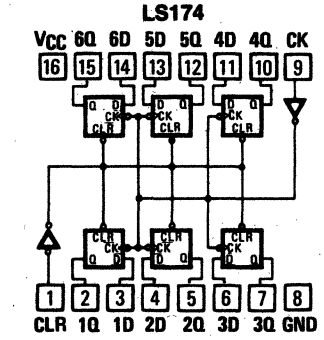
FUNCTION TABLE (EACH FLIP-FLOP)

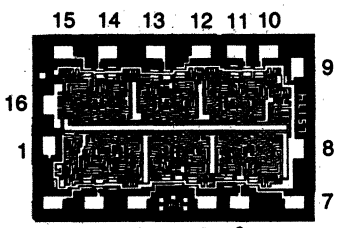
INPUTS			OUTPUTS	
CLEAR	CLOCK	D	Q	$\bar{Q}$†
L	X	X	L	H
H	↑	H	H	L
H	↑	L	L	H
H	L	X	Q_0	$\bar{Q}_0$

H = high level (steady state)
L = low level (steady state)
X = irrelevant
↑ = transition from low to high level
Q_0 = the level of Q before the indicated steady state input conditions were established.
† = LS175 only

PIN-OUT DIAGRAMS

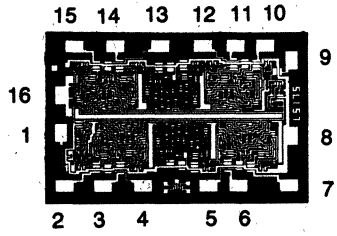
LS174

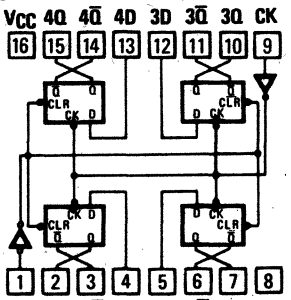




Die Size .056 x .085

LS175

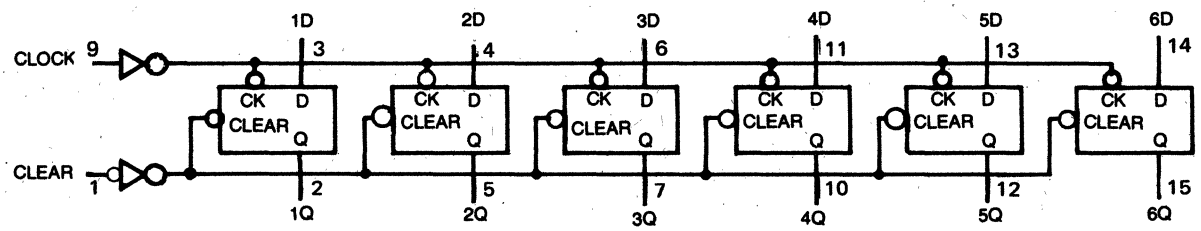




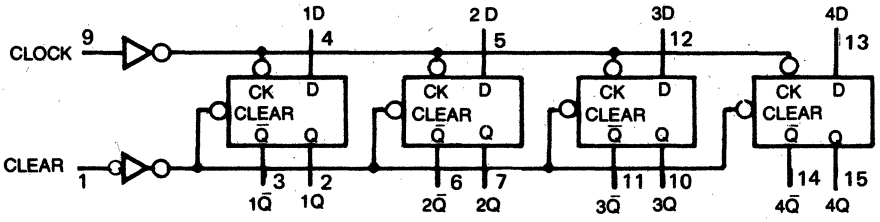
Die Size .056 x .085

LOGIC DIAGRAMS

LS174



LS175



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Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}				-400			-400	μA
Low-level output current, I_{OL}				4			8	mA
Clock frequency, f_{clock}		0		35	0		35	MHz
Width of clock pulse, t_w (Low)		15			15			ns
Width of clear pulse, t_w (Low)		20			20			ns
Setup time	Data input t_{setup}	10			10			ns
	Clear recovery, t_{rec}	12			12			ns
Data hold time, t_{hold}		5			5			ns
Operating free-air temperature, T_A		-55		125	0		70	°C

t_{setup} is the minimum time required for the correct logic level to be present at the data input prior to the rising edge of the clock in order to be recognized and transferred to the output.

t_{hold} is the minimum time required for the logic level to be maintained at the data input after the rising edge of the clock in order to insure recognition.

t_{rec} is the minimum time required between the end of the clear pulse and the rising edge of the clock in order to transfer High data to the Q output.

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-400μA		2.5	3.5		2.7	3.5		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4		0.25	0.40	V
		I_{OL}=8mA					0.35	0.5	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V	Clock, Clear			-0.4			-0.4	mA
		Other inputs			-0.36			-0.36	
I_{OS}†	V_{CC}=MAX		-15		-100	-15		-100	mA
I_{CC}††	V_{CC}=MAX	LS174		16	26		16	26	mA
		LS175		11	18		11	18	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
††With all outputs open and 4.5V applied to all data and clear inputs, I_{CC} is measured, after a momentary ground, then 4.5V is applied to clock.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	-55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A on page 2-147)										
f_{max}				35	45					MHz
t_{PLH} (LS175 only)					19	24				ns
t_{PHL}					23	31				ns
t_{PLH}					14	20				ns
t_{PHL}					14	22				ns

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4-Bit Arithmetic Logic Unit

LS181

FEATURES

- **Provides 16 arithmetic operations**
- **Provides 16 logic operations**
- **Full look-ahead for high-speed arithmetic operation on long words**

DESCRIPTION

The LS181 is an arithmetic logic unit (ALU)/function generator which has a complexity of 75 equivalent gates on a monolithic chip. This circuit performs 16 binary arithmetic operations on two 4-bit words as shown in Tables 1 and 2. These operations are selected by the four function-select lines (S0, S1, S2, S3) and include addition, subtraction, decrement, and straight transfer. When performing arithmetic manipulations, the internal carries must be enabled by applying a low-level voltage to the mode control input (M). A full carry look-ahead scheme is made available in these devices for fast, simultaneous carry generation by means of two cascade-outputs (pins 15 and 17) for the four bits in the package. When used in conjunction with the 182, full carry ahead look-ahead circuits, high-speed arithmetic operations can be performed.

If high speed is not of importance, a ripple-carry input (C_n) and a ripple-carry output (C_{n+4}) are available. However, the ripple-carry delay has also been minimized so that arithmetic manipulations for small word lengths can be performed without external circuitry.

The LS181 will accommodate active-high or active-low data if the pin designations are interpreted as follows:

Subtraction is accomplished by 1's complement addition where the 1's complement of the subtrahend is generated internally. The resultant output is A-B-1 which requires an end-around or forced carry to provide A-B.

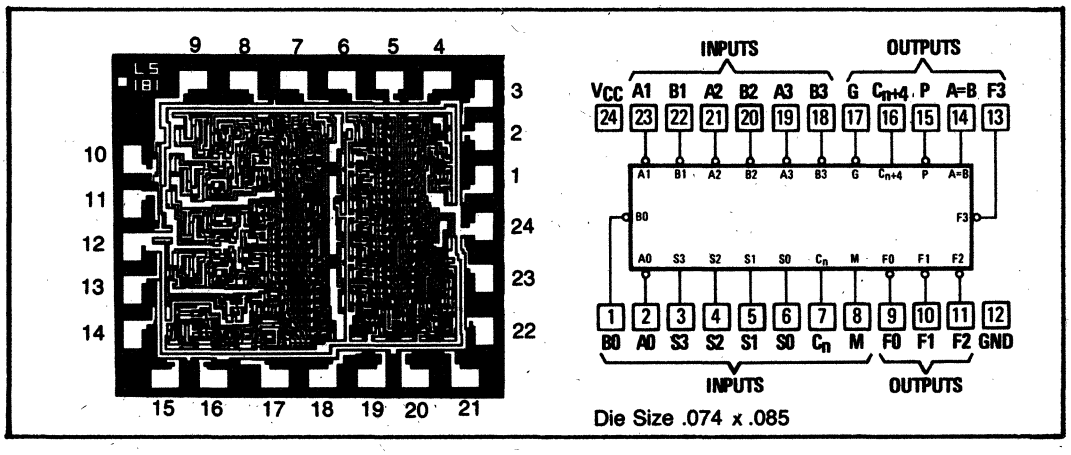
The LS181 can also be utilized as a comparator. The A = B output is internally decoded from the function outputs (F0, F1, F2, F3) so that when two words of equal magnitude are applied at the A and B inputs, it will assume a high level to indicate equality (A = B). The ALU should be in the subtract mode with C_n = H when performing this comparison. The A = B output is open-collector so that it can be wire-AND connected to give a comparison for more than four bits. The carry output (C_{n+4}) can also be used to supply relative magnitude information. Again, the ALU should be placed in the subtract mode by placing the function select inputs, S3, S2, S1, S0 at L, H, H, L, respectively.

INPUT $\overline{C}_n$	OUTPUT $\overline{C}_{n+4}$	ACTIVE-HIGH DATA (FIGURE 1)	ACTIVE-LOW DATA (FIGURE 2)
H	H	A ≤ B	A ≥ B
H	L	A > B	A < B
L	H	A < B	A > B
L	L	A ≥ B	A ≤ B

These circuits have been designed to not only incorporate all of the designer's requirements for arithmetic operations, but also provide 16 possible functions of two Boolean variables without the use of external circuitry. These logic functions are selected by use of the four function-select inputs (S0, S1, S2, S3) with the mode-control input (M) at a high level to disable the internal carry. The 16 logic functions are detailed in Tables 1 and 2 and include exclusive-OR, NAND, AND, NOR, and OR functions.

PIN NUMBER	2	1	23	22	21	20	19	18	9	10	11	13	7	16	15	17
Active-low data (Table 1)	A_0	B_0	A_1	B_1	A_2	B_2	A_3	B_3	F_0	F_1	F_2	F_3	$\overline{C}_n$	$\overline{C}_{n+4}$	X	Y
Active-low data (Table 2)	$\overline{A}_0$	$\overline{B}_0$	$\overline{A}_1$	$\overline{B}_1$	$\overline{A}_2$	$\overline{B}_2$	$\overline{A}_3$	$\overline{B}_3$	$\overline{F}_0$	$\overline{F}_1$	$\overline{F}_2$	$\overline{F}_3$	C_n	C_{n+4}	$\overline{P}$	$\overline{G}$

PIN-OUT DIAGRAM



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ALU SIGNAL DESIGNATIONS

The LS181 can be used with the signal designations of either Figure 1 or Figure 2.

The logic functions and arithmetic operations obtained with signal designations as in Figure 1 are given in Table 1; those obtained with the signal designations of Figure 2 are given in Table 2.

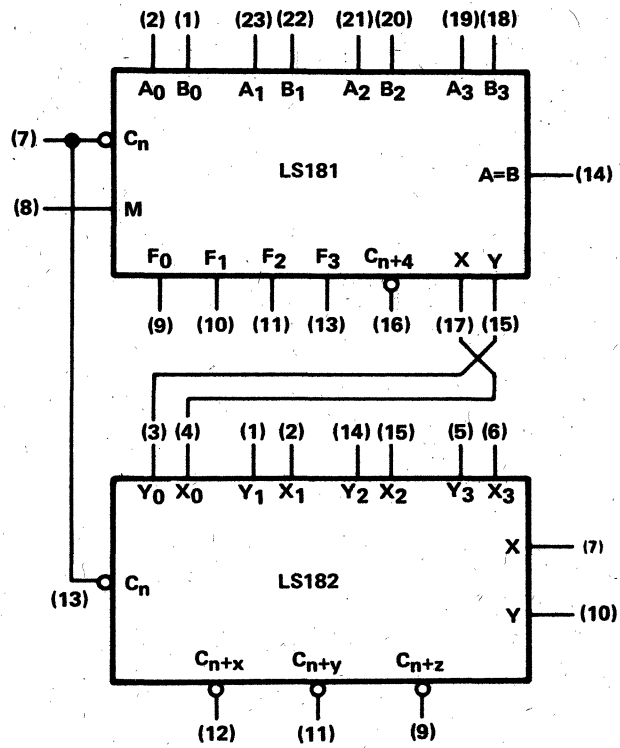

FIGURE 1
(FOR TABLE 1)

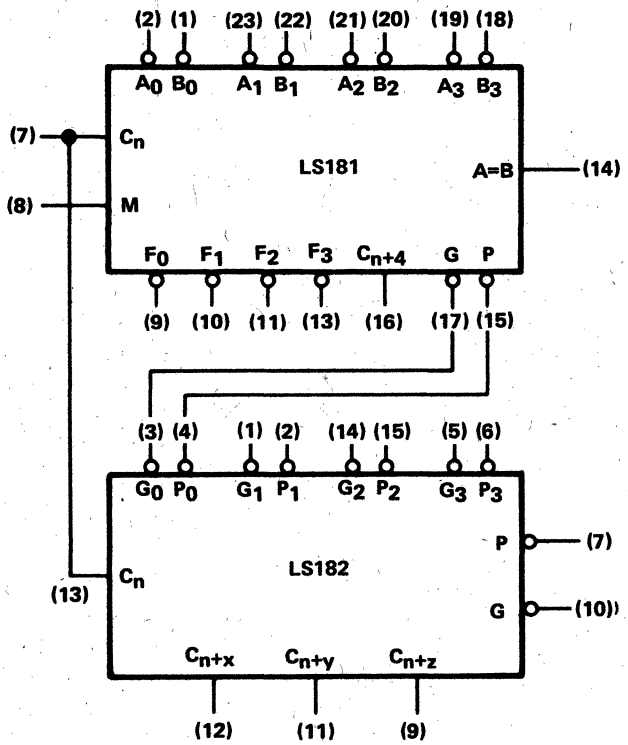

FIGURE 2
(FOR TABLE 2)

TABLE 1

SELECTION S_3 S_2 S_1 S_0	ACTIVE-HIGH DATA		
	M = H	M = L; ARITHMETIC OPERATIONS	
	LOGIC FUNCTIONS	C_n = H (no carry)	C_n = L (no carry)
L L L L	F = $\overline{A}$	F = A	F = A PLUS 1
L L L H	F = $\overline{A+B}$	F = A + B	F = (A + B) PLUS 1
L L H L	F = $\overline{A}B$	F = A + $\overline{B}$	F = (A + $\overline{B}$) PLUS 1
L L H H	F = 0	F = MINUS 1 (2's COMPL)	F = ZERO
L H L L	F = $\overline{AB}$	F = A PLUS A$\overline{B}$	F = A PLUS A$\overline{B}$ PLUS 1
L H L H	F = $\overline{B}$	F = (A + B) PLUS A$\overline{B}$	F = (A + B) PLUS A$\overline{B}$ PLUS 1
L H H L	F = A $\oplus$ B	F = A MINUS B MINUS 1	F = A MINUS B
L H H H	F = A$\overline{B}$	F = A$\overline{B}$ MINUS 1	F = A$\overline{B}$
H L L L	F = $\overline{A}$ + B	F = A PLUS AB	F = A PLUS AB PLUS 1
H L L H	F = $\overline{A \oplus B}$	F = A PLUS B	F = A PLUS B PLUS 1
H L H L	F = B	F = (A + $\overline{B}$) PLUS AB	F = (A + $\overline{B}$) PLUS AB PLUS 1
H L H H	F = AB	F = AB MINUS 1	F = AB
H H L L	F = 1	F = A PLUS A*	F = A PLUS A PLUS 1
H H L H	F = A + $\overline{B}$	F = (A + B) PLUS A	F = (A + B) PLUS A PLUS 1
H H H L	F = A + B	F = (A + $\overline{B}$) PLUS A	F = (A + $\overline{B}$) PLUS A PLUS 1
H H H H	F = A	F = A MINUS 1	F = A

TABLE 2

SELECTION S_3 S_2 S_1 S_0	ACTIVE-LOW DATA		
	M = H	M = L; ARITHMETIC OPERATIONS	
	LOGIC FUNCTIONS	C_n = L (with carry)	C_n = H (with carry)
L L L L	F = $\overline{A}$	F = A MINUS 1	F = A
L L L H	F = $\overline{AB}$	F = AB MINUS 1	F = AB
L L H L	F = $\overline{A}$ + B	F = A$\overline{B}$ MINUS 1	F = A$\overline{B}$
L L H H	F = 1	F = MINUS 1 (2's COMP)	F = ZERO
L H L L	F = $\overline{A+B}$	F = A PLUS (A + $\overline{B}$)	F = A PLUS (A + $\overline{B}$) PLUS 1
L H L H	F = $\overline{B}$	F = AB PLUS (A + $\overline{B}$)	F = AB PLUS (A + $\overline{B}$) PLUS 1
L H H L	F = $\overline{A \oplus B}$	F = A MINUS B MINUS 1	F = A MINUS B
L H H H	F = A + $\overline{B}$	F = A + $\overline{B}$	F = (A + $\overline{B}$) PLUS 1
H L L L	F = $\overline{A}$B	F = A PLUS (A + B)	F = A PLUS (A + B) PLUS 1
H L L H	F = A $\oplus$ B	F = A PLUS B	F = A PLUS B PLUS 1
H L H L	F = B	F = A$\overline{B}$ PLUS (A + B)	F = A$\overline{B}$ PLUS (A + B) PLUS 1
H L H H	F = A + B	F = A + B	F = (A + B) PLUS 1
H H L L	F = 0	F = A PLUS A*	F = A PLUS A PLUS 1
H H L H	F = A$\overline{B}$	F = AB PLUS A	F = AB PLUS A PLUS 1
H H H L	F = AB	F = A$\overline{B}$ PLUS A	F = A$\overline{B}$ PLUS A PLUS 1
H H H H	F = A	F = A	F = A PLUS 1

*Each bit is shifted to the next more significant position.

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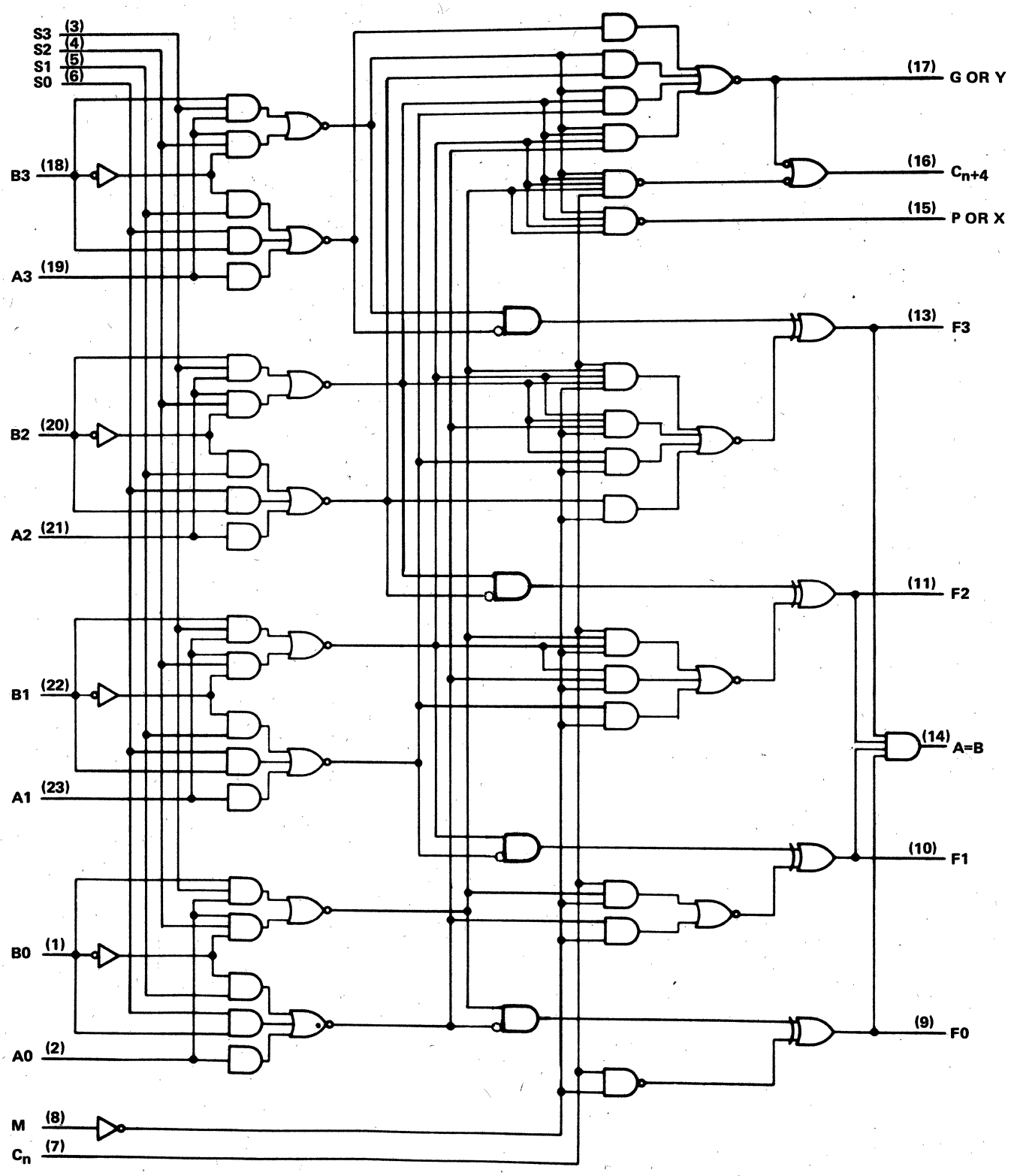
4-Bit Arithmetic Logic Unit

LOGIC DIAGRAM



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Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH} (All outputs except A = B)			−400			−400	μA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	−55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS			9LS/74LS			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=−18mA				−1.5			−1.5	V
V_{OH}	Any Output except A = B	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=−400μA		2.5	3.4		2.7	3.4		V
I_{OH}	A = B Output only	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, V_{OH}=5.5V				100			100	μA
V_{OL}	All outputs	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4				V
			I_{OL}=8mA		0.35	0.6				
	Output G		I_{OL}=16mA		0.47	0.7			0.5	
I_I	Mode input	V_{CC}=MAX, V_I=7.0V				0.1			0.1	mA
	Any A or B input					0.3			0.3	
	Any S input					0.4			0.4	
	Carry input					0.5			0.5	
I_{IH}	Mode input	V_{CC}=MAX, V_I=2.7V				20			20	μA
	Any A or B					60			60	
	Any S input					80			80	
	Carry input					100			100	
I_{IL}	Mode input	V_{CC}=MAX, V_I=0.4V				−0.36			−0.36	mA
	Any A or B input					−1.08			−1.08	
	Any S input					−1.44			−1.44	
	Carry input					−2			−2	
I_{OS}†	Any Output except A=B	V_{CC}=MAX		−15		−100	−15		−100	mA
I_{CC}††		V_{CC}=MAX	Condition A		20	32		20	34	mA
			Condition B		21	35		21	37	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

††With outputs open, I_{CC} is measured for the following conditions:

A. S0 through S3, M and A inputs are at 4.5V, all other inputs are grounded.

B. S0 through S3 and M are at 4.5V, all other inputs are grounded.

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4-Bit Arithmetic Logic Unit

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter ¶	From (Input)	To (Output)	−55°C			+25°C			+125°C			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A on page 2-147)												
t_{PLH}	C_n	C_{n+4}					14	24				ns
t_{PHL}							13	20				
M = 0V, S0 = S3 = 4.5V, S1 = S2 = 0V ($\overline{SUM}$ mode)												
t_{PLH}	Any A or B	C_{n+4}					24	35				ns
t_{PHL}							17	30				
M = 0V, S0 = S3 = 0V, S1 = S2 = 4.5V ($\overline{DIFF}$ mode)												
t_{PLH}	Any A or B	C_{n+4}					24	38				ns
t_{PHL}							25	38				
M = 0V, ($\overline{SUM}$ or $\overline{DIFF}$ mode)												
t_{PLH}	C_n	Any F					12	24				ns
t_{PHL}							12	20				
M = 0V, S0 = S3 = 4.5V, S1 = S2 = 0V ($\overline{SUM}$ mode)												
t_{PLH}	Any A or B	G					12	29				ns
t_{PHL}							15	23				
M = 0V, S0 = S3 = 0V, S1 = S2 = 4.5V ($\overline{DIFF}$ mode)												
t_{PLH}	Any A or B	G					20	30				ns
t_{PHL}							17	26				
M = 0V, S0 = S3 = 4.5V, S1 = S2 = 4.5V ($\overline{SUM}$ mode)												
t_{PLH}	Any A or B	P					14	28				ns
t_{PHL}							20	30				
M = 0V, S0 = S3 = 0V, S1 = S2 = 4.5V ($\overline{DIFF}$ mode)												
t_{PLH}	Any A or B	P					20	30				ns
t_{PHL}							22	33				
M = 0V, S0 = S3 = 4.5V, S1 = S2 = 0V ($\overline{SUM}$ mode)												
t_{PLH}	A_i or B_i	F_i					15	30				ns
t_{PHL}							13	20				
M = 0V, S0 = S3 = 0V, S1 = S2 = 4.5V ($\overline{DIFF}$ mode)												
t_{PLH}	A_i or B_i	F_i					21	32				ns
t_{PHL}							15	23				
M = 4.5V (logic mode)												
t_{PLH}	A_i or B_i	F_i					17	30				ns
t_{PHL}							15	29				
M = 0V, S0 = S3 = 0V, S1 = S2 = 4.5V ($\overline{DIFF}$ mode)												
t_{PLH}	Any A or B	A = B					33	50				ns
t_{PHL}							29	45				

¶ t_{PLH} = propagation delay time, low-to-high-level output t_{PHL} = propagation delay time, high-to-low-level output.

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PARAMETER MEASUREMENT INFORMATION

$\overline{\text{SUM}}$ MODE TEST TABLE

FUNCTION INPUTS: S0 = S3 = 4.5 V, S1 = S2 = M = 0 V

PARAMETER	INPUT UNDER TEST	OTHER INPUT SAME BIT		OTHER DATA INPUTS		OUTPUT UNDER TEST	OUTPUT WAVEFORM
		APPLY 4.5 V	APPLY GND	APPLY 4.5 V	APPLY GND		
t_{PLH} / t_{PHL}	A_i	B_i	None	Remaining A and B	C_n	F_i	In-Phase
t_{PLH} / t_{PHL}	B_i	A_i	None	Remaining A and B	C_n	F_i	In-Phase
t_{PLH} / t_{PHL}	A_i	B_i	None	None	Remaining A and B, C_n	P	In-Phase
t_{PLH} / t_{PHL}	B_i	A_i	None	None	Remaining A and B, C_n	P	In-Phase
t_{PLH} / t_{PHL}	A_i	None	B_i	Remaining B	Remaining A, C_n	G	In-Phase
t_{PLH} / t_{PHL}	B_i	None	A_i	Remaining B	Remaining A, C_n	G	In-Phase
t_{PLH} / t_{PHL}	C_n	None	None	All A	All B	Any F or C_{n+4}	In-Phase
t_{PLH} / t_{PHL}	A_i	None	B_i	Remaining B	Remaining A, C_n	C_{n+4}	Out-of-Phase
t_{PLH} / t_{PHL}	B_i	None	A_i	Remaining B	Remaining A, C_n	C_{n+4}	Out-of-Phase

$\overline{\text{DIFF}}$ MODE TEST TABLE

FUNCTION INPUTS: S1 = S2 = 4.5 V, S0 = S3 = M = 0 V

PARAMETER	INPUT UNDER TEST	OTHER INPUT SAME BIT		OTHER DATA INPUTS		OUTPUT UNDER TEST	OUTPUT WAVEFORM
		APPLY 4.5 V	APPLY GND	APPLY 4.5 V	APPLY GND		
t_{PLH} / t_{PHL}	A_i	None	B_i	Remaining A	Remaining B, C_n	F_i	In-Phase
t_{PLH} / t_{PHL}	B_i	A_i	None	Remaining A	Remaining B, C_n	F_i	Out-of-Phase
t_{PLH} / t_{PHL}	A_i	None	B_i	None	Remaining A and B, C_n	P	In-Phase
t_{PLH} / t_{PHL}	B_i	A_i	None	None	Remaining A and B, C_n	P	Out-of-Phase
t_{PLH} / t_{PHL}	A_i	B_i	None	None	Remaining A and B, C_n	G	In-Phase
t_{PLH} / t_{PHL}	B_i	None	A_i	None	Remaining A and B, C_n	G	Out-of-Phase
t_{PLH} / t_{PHL}	A_i	None	B_i	Remaining A	Remaining B, C_n	A = B	In-Phase
t_{PLH} / t_{PHL}	B_i	A_i	None	Remaining A	Remaining B, C_n	A = B	Out-of Phase
t_{PLH} / t_{PHL}	C_n	None	None	All A and B	None	C_{n+4} or any F	In-Phase
t_{PLH} / t_{PHL}	A_i	B_i	None	None	Remaining A, B, C_n	C_{n+4}	Out-of-Phase
t_{PLH} / t_{PHL}	B_i	None	A_i	None	Remaining A, B, C_n	C_{n+4}	In -Phase

LOGIC MODE TEST TABLE

FUNCTION INPUTS: S1 = S2 = M = 4.5 V, S0 = S3 = 0 V

PARAMETER	INPUT UNDER TEST	OTHER INPUT SAME BIT		OTHER DATA INPUTS		OUTPUT UNDER TEST	OUTPUT WAVEFORM
		APPLY 4.5 V	APPLY GND	APPLY 4.5 V	APPLY GND		
t_{PLH} / t_{PHL}	A_i	B_i	None	None	Remaining A and B, C_n	F_i	Out-of-Phase
t_{PLH} / t_{PHL}	B_i	A_i	None	None	Remaining A and B, C_n	F_i	Out-of-Phase

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Synchronous BCD Decade Up/Down Counter — LS190

Synchronous 4-Bit Binary Up/Down Counter — LS191

FEATURES

- **Single up/down count mode control line**
- **Asynchronous parallel load**
- **Count enable, parallel load control inputs**
- **Cascadable**

DESCRIPTION

The LS190 and LS191 are synchronous, reversible up/down counters having a complexity of 58 equivalent gates. The LS191 is a 4-bit binary counter and the LS190 is a BCD counter. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the steering logic. This mode of operation eliminates the output counting spikes normally associated with asynchronous (ripple clock) counters.

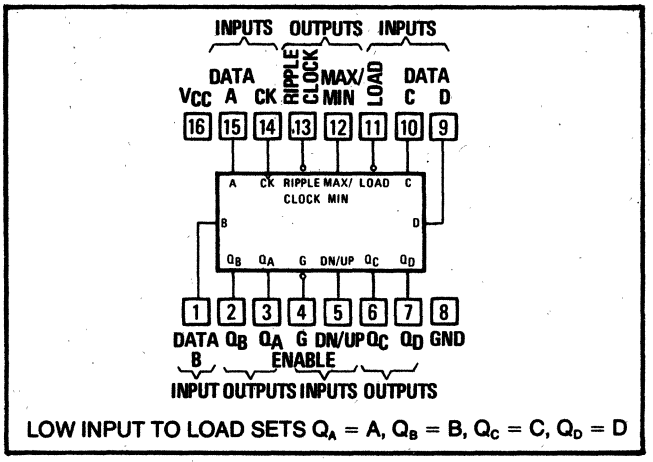
The outputs of the four master-slave flip-flops are triggered on a low-to-high-level transition of the clock input if the enable input is low. A high at the enable input inhibits counting. Level changes at the enable and down/up inputs should be made only when the clock input is high. The direction of the count is determined by the level of the down/up input. When low, the counter counts up and when high, it counts down.

These counters are fully programmable; that is, the outputs may be preset to either level by placing a low on the load input and entering the desired data at the data inputs. The output will change to agree with the data inputs independently of the level of the clock input. This feature allows the counters to be used as modulo-N dividers by simply modifying the count length with the preset inputs.

The clock, down/up, and load inputs are buffered to lower the drive requirement which significantly reduces the number of clock drivers, etc., required for long parallel words.

Two outputs have been made available to perform the cascading function: ripple clock and maximum/minimum count. The latter output produces a high-level output pulse with a duration approximately equal to one complete cycle of the clock when the counter overflows or underflows. The ripple clock output produces a low-level output pulse equal in width to the low-level portion of the clock input when an overflow or underflow condition exists. The counters can be easily cascaded by feeding the ripple clock output to the enable input of the succeeding counter if parallel clocking is used, or to the clock input if parallel enabling is used. The maximum/minimum count output can be used to accomplish look-ahead for high-speed operation.

PIN-OUT DIAGRAM



LOW INPUT TO LOAD SETS Q_A = A, Q_B = B, Q_C = C, Q_D = D

Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-400			-400	μA
Low-level output current, I_{OL}			4			8	mA
Input clock frequency, f_{clock}	0		20	0		20	MHz
Width of clock input pulse, $t_{w(clock)}$	25			25			ns
Width of load input pulse, $t_{w(load)}$	35			35			ns
Data setup time, t_{setup} (see Figures 1 and 2)	20			20			ns
Enable to clock setup time, t_{setup}	20			20			ns
Data hold time, t_{hold}	0			0			ns
Operating free-air temperature, T_A	-55		125	0		70	°C

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Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS			9LS/74LS			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-400μA		2.5	3.4		2.7	3.4		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.40		0.25	0.40	V
			I_{OL}=8mA					0.35	0.5	
I_I	Enable	V_{CC}=MAX, V_I=7V				0.3			0.3	mA
	Others					0.1			0.1	
I_{IH}	Enable	V_{CC}=MAX, V_I=2.7V				60			60	μA
	Others					20			20	
I_{IL}	Enable	V_{CC}=MAX, V_I=0.4V				-1.08			-1.08	mA
	Others					-0.4			-0.4	
I_{OS}†		V_{CC}=MAX		-15		-100	-15		-100	mA
I_{CC}††		V_{CC}=MAX			20	35		20	35	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
††I_{CC} is measured with all inputs grounded and all outputs open.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter¶	From (input)	To (output)	−55°C			+25°C			+125°C			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. 1 and 3 thru 7 on pages 2-99 and 2-100)												
f_{max}						20	25					MHz
t_{PLH}	Load	Q_A,Q_B,Q_C,Q_D					22	33				ns
t_{PHL}							33	50				
t_{PLH}	Data A,B,C,D	Q_A,Q_B,Q_C,Q_D					14	22				ns
t_{PHL}							35	50				
t_{PLH}	Clock	Ripple Clock					13	20				ns
t_{PHL}							16	24				
t_{PLH}	Clock	Q_A,Q_B,Q_C,Q_D					16	24				ns
t_{PHL}							24	36				
t_{PLH}	Clock	Max/Min					28	42				ns
t_{PHL}							37	52				
t_{PLH}	Down/Up	Ripple Clock					30	45				ns
t_{PHL}							30	45				
t_{PLH}	Down/Up	Max/Min					21	33				ns
t_{PHL}							22	33				
t_{PLH}	Enable	Ripple Clock					21	33				ns
t_{PHL}							22	33				

¶f_{max} = maximum clock frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

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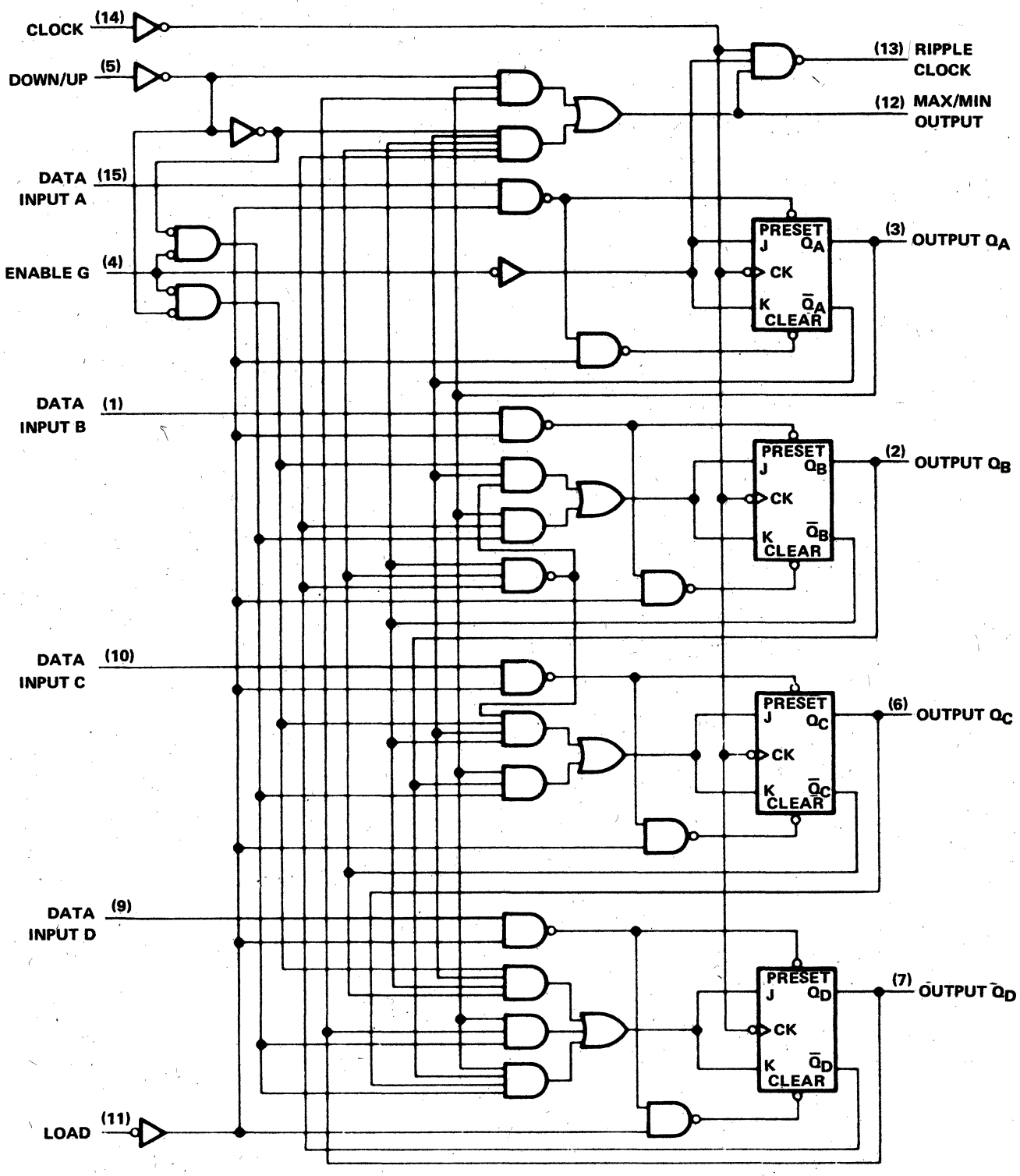
Synchronous BCD Decade Up/Down Counter — LS190
Synchronous 4-Bit Binary Up/Down Counter — LS191

LOGIC DIAGRAM

LS190



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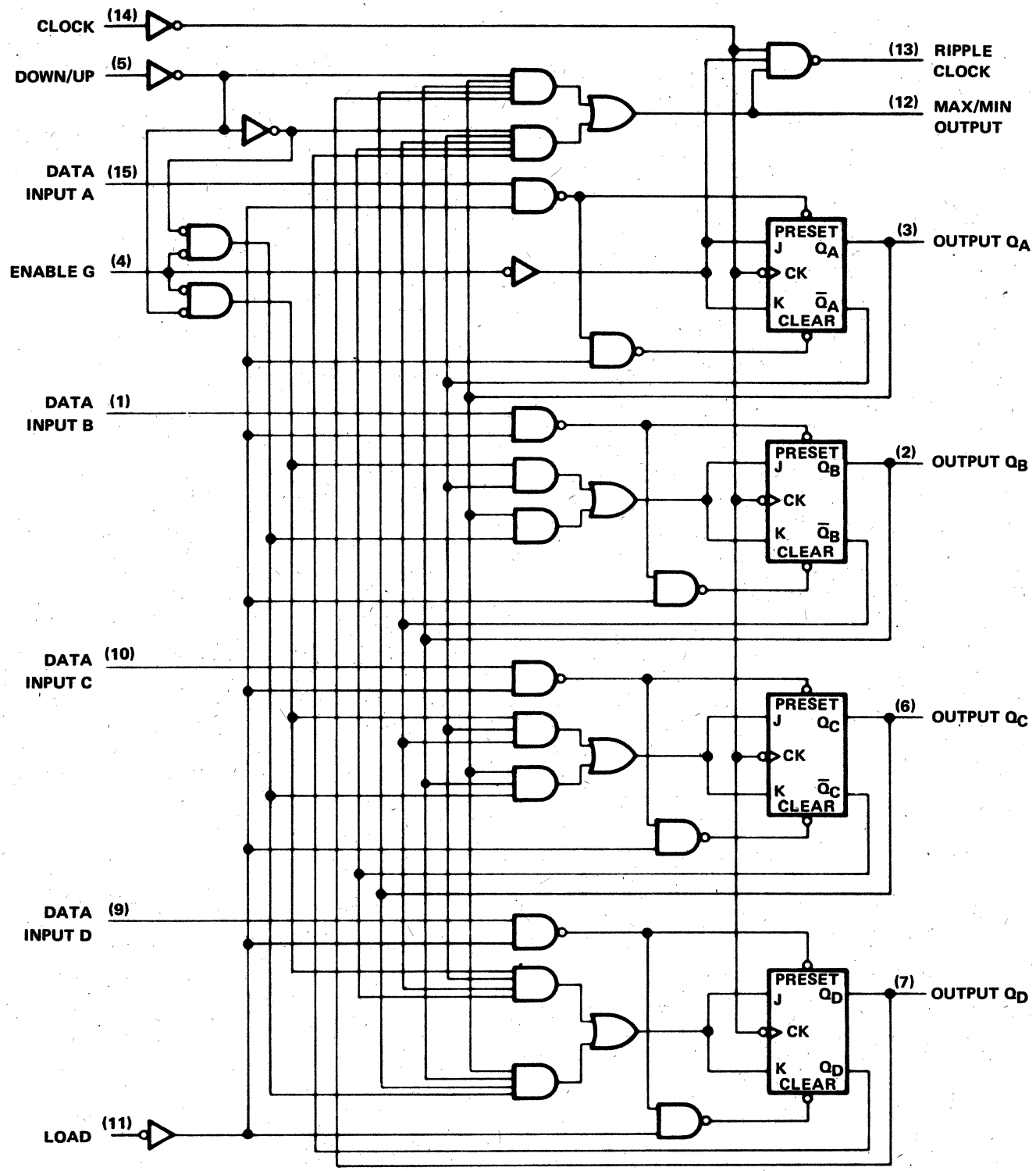
LOGIC DIAGRAM
LS191



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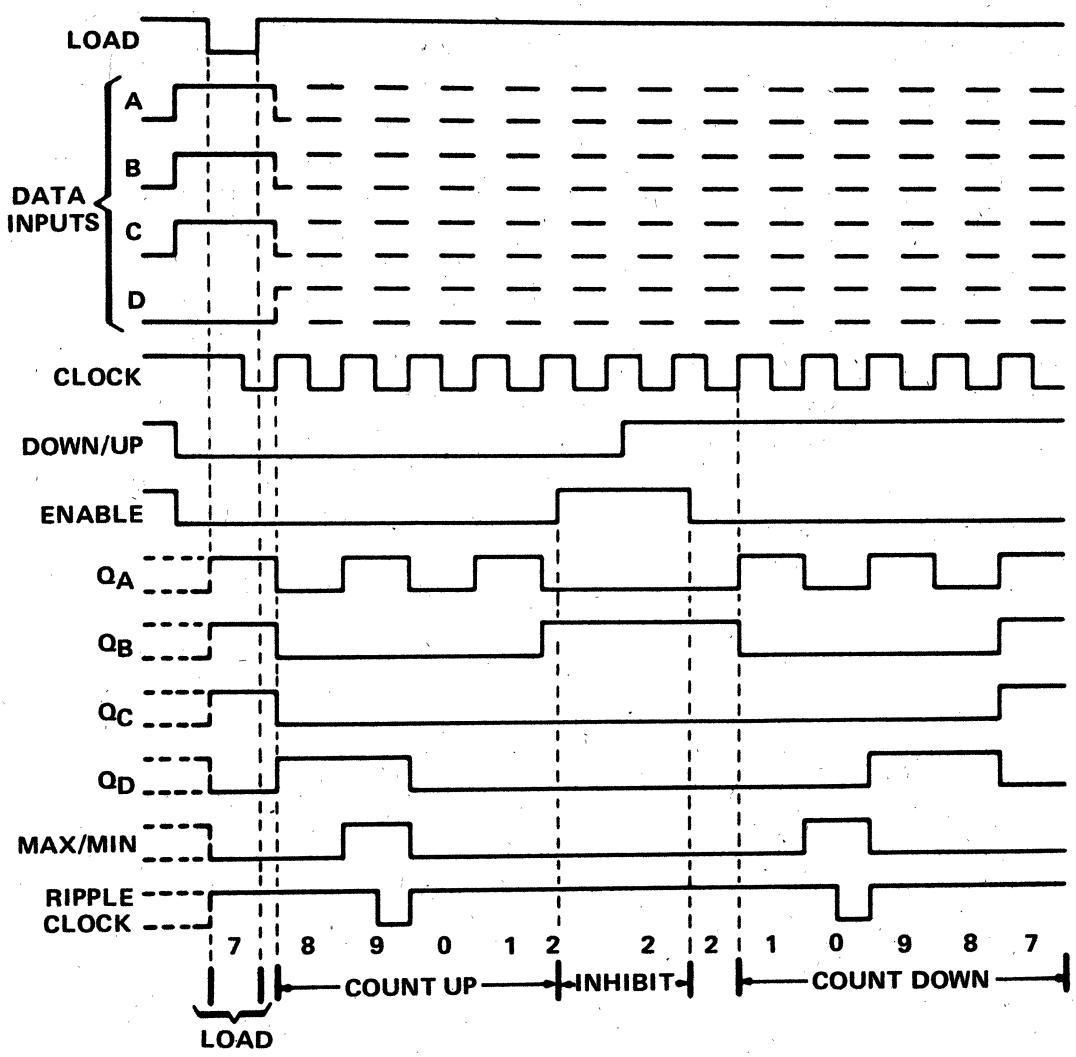
Synchronous BCD Decade Up/Down Counter — LS190
Synchronous 4-Bit Binary Up/Down Counter — LS191

LS190 TYPICAL LOAD, COUNT AND INHIBIT SEQUENCES

Illustrated below is the following sequence:

1. Load (preset) to BCD seven.
2. Count up to eight, nine (maximum), zero, one, and two.
3. Inhibit.
4. Count down to one, zero (minimum), nine, eight, and seven.



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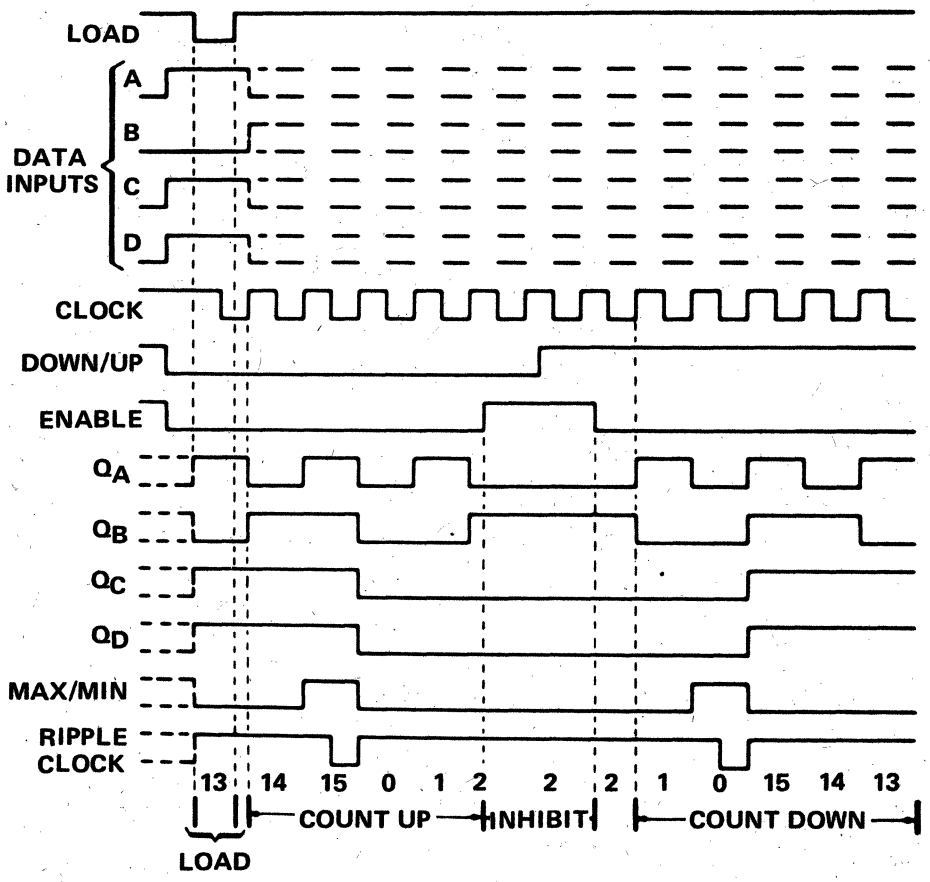
LS191 TYPICAL LOAD, COUNT AND INHIBIT SEQUENCES

Illustrated below is the following sequence:

1. Load (preset) to binary thirteen.
2. Count up to fourteen, fifteen (maximum), zero, one, and two.
3. Inhibit.
4. Count down to one, zero (minimum), fifteen, fourteen, and thirteen.



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Synchronous BCD Decade Up/Down Counter — LS190
Synchronous 4-Bit Binary Up/Down Counter — LS191

PARAMETER MEASUREMENT INFORMATION

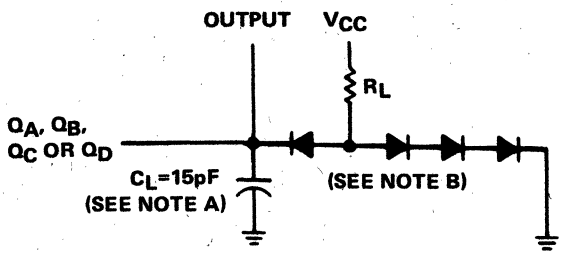


FIGURE 1—LOAD CIRCUIT
FOR SWITCHING TIME MEASUREMENT

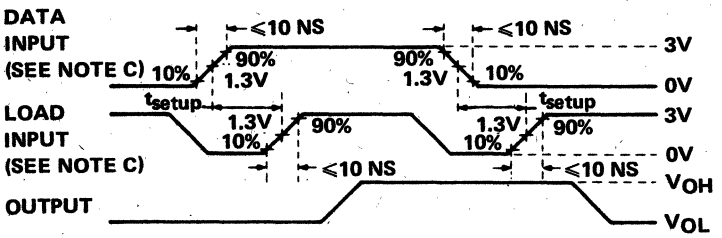


FIGURE 2—DATA SETUP TIME VOLTAGE WAVEFORMS

See waveform sequences in Figures 4 through 7 for propagation times from a specific input to a specific output. For simplification, pulse rise times, reference levels, etc., have not been shown in Figures 4 through 7.

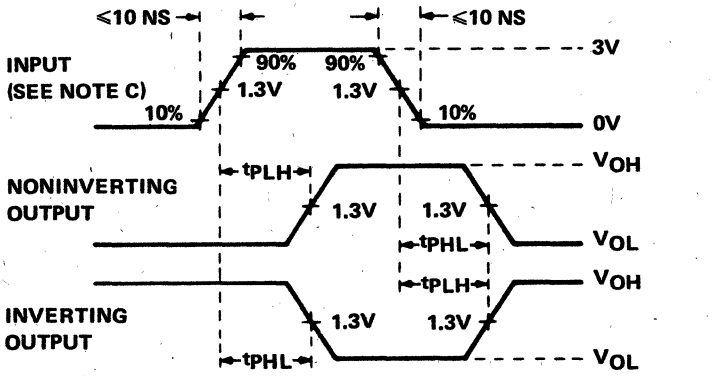
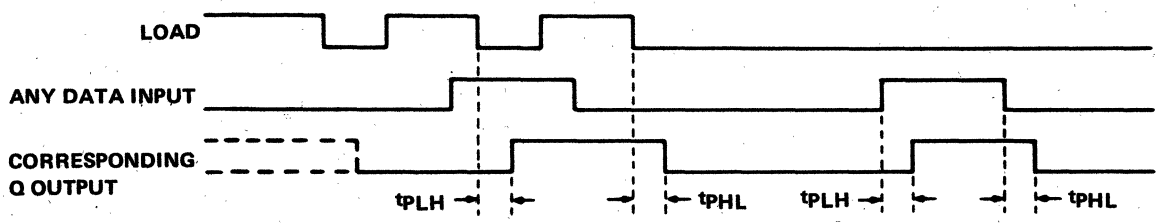


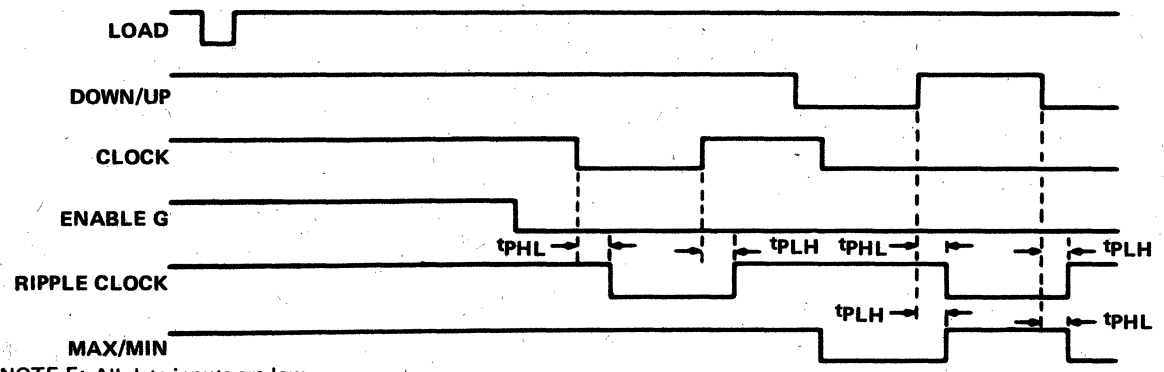
FIGURE 3— GENERAL VOLTAGE WAVEFORMS
FOR PROPAGATION TIMES

NOTES:
A. C_L includes probe and jig capacitance.
B. All diodes are 1N3064.
C. The input pulses are supplied by generators having the following characteristics: $Z_{out} = 50\Omega$, duty cycle ≤ 50%, PRR ≤ 1MHz.



NOTE D: Conditions on other inputs are irrelevant.

FIGURE 4—LOAD TO OUTPUT AND DATA TO OUTPUT



NOTE E: All data inputs are low.

FIGURE 5—ENABLE TO RIPPLE CLOCK, CLOCK TO RIPPLE CLOCK, DOWN/UP TO MAX/MIN

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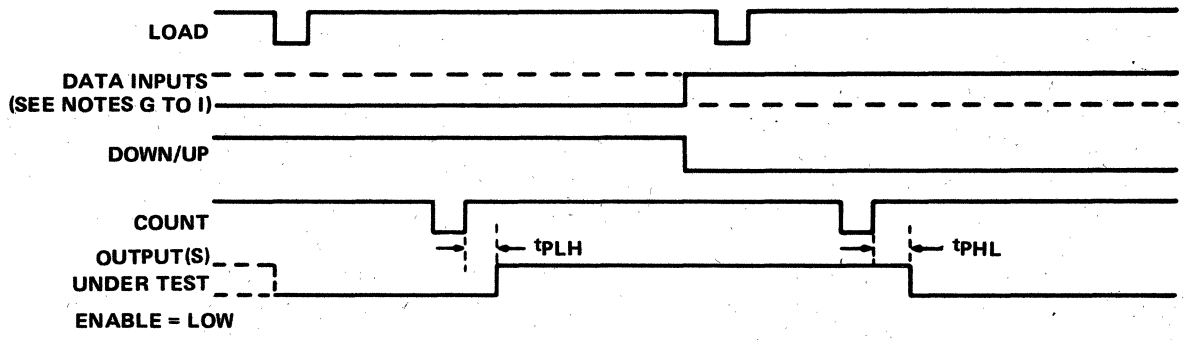
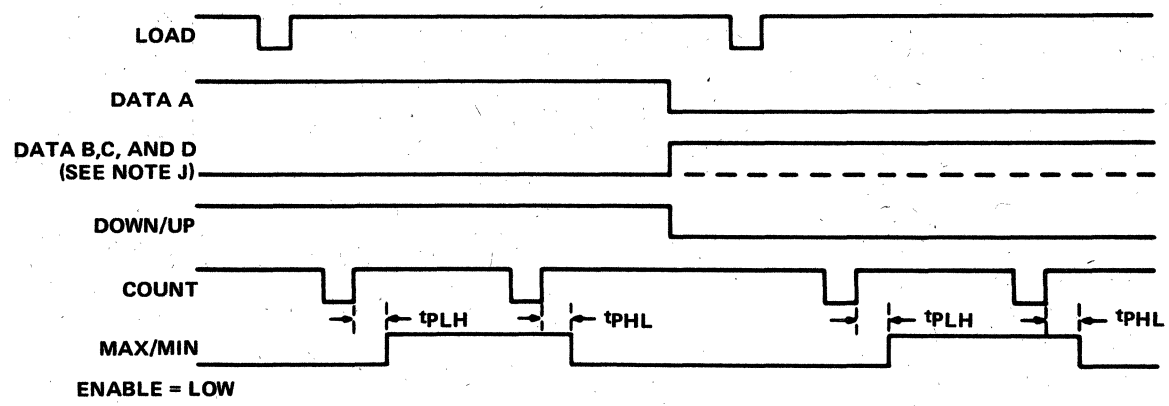
PARAMETER MEASUREMENT INFORMATION (Continued)



F. to test Q_A, Q_B, and Q_C outputs of LS190: Data inputs A, B, and C are shown by the solid line. Data input D is shown by the dashed line.
G. To test Q_D output of LS190: Data inputs A and D are shown by the solid line. Data inputs B and C are held at the low logic level.
H. To test Q_A, Q_B, Q_C, and Q_D outputs of LS191: All four data inputs are shown by the solid line.

FIGURE 6–CLOCK TO OUTPUT



NOTE I:
Data inputs B and C are shown by the dashed line for the LS190 and the solid line for the LS191: Data input D is shown by the solid line for both devices.

FIGURE 7–CLOCK TO MAX/MIN

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Synchronous BCD Decade Up/Down Counter — LS192

Synchronous 4-Bit Binary Up/Down Counter — LS193

FEATURES

- Separate clock inputs for count-up, count-down
- Asynchronous parallel load and clear
- Cascadable

DESCRIPTION

These monolithic circuits are synchronous reversible (up/down) counters having a complexity of 55 equivalent gates. The LS192 is a BCD counter and the LS193 is a 4-bit binary counter. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincidently with each other when so instructed by the steering logic. This mode of operation eliminates the output counting spikes which are normally associated with asynchronous (ripple-clock) counters.

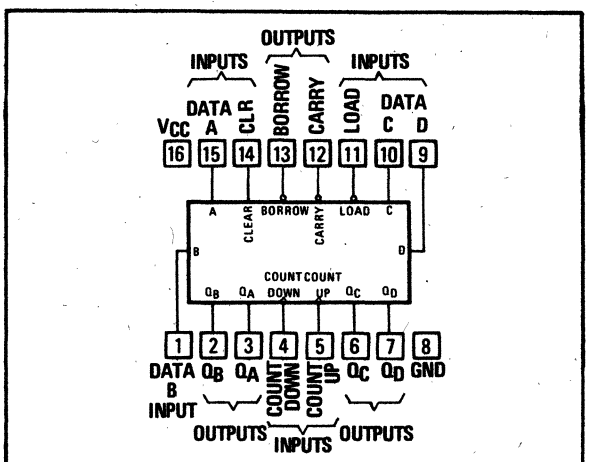
The outputs of the four master-slave flip-flops are triggered by a low-to-high-level transition of either count (clock) input. The direction of counting is determined by which count input is pulsed while the other count input is high.

All four counters are fully programmable; that is, each output may be preset to either level by entering the desired data at the data inputs while the load input is low. The output will change to agree with the data inputs independently of the count pulses. This feature allows the counters to be used as modulo-N dividers by simply modifying the count length with the preset inputs.

A clear input has been provided which forces all outputs to the low level when a high level is applied. The clear function is independent of the count and load inputs. The clear, count, and load inputs are buffered to lower the drive requirements. This reduces the number of clock drivers, etc., required for long words.

These counters were designed to be cascaded without the need for external circuitry. Both borrow and carry outputs are available to cascade both the up- and down-counting functions. The borrow output produces a pulse equal in width to the count-down input when the counter underflows. Similarly, the carry output produces a pulse equal in width to the count-down input when an overflow condition exists. The counters can then be easily cascaded by feeding the borrow and carry outputs to the count-down and count-up inputs respectively of the succeeding counter.

PIN-OUT DIAGRAM



Low input to load sets Q_A = A, Q_B = B, Q_C = C, and Q_D = D

Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-400			-400	μA
Low-level output current, I_{OL}			4			8	mA
Count frequency, f_{count}	0		25	0		25	MHz
Width of any input pulse, t_w	20			20			ns
Data setup time, t_{setup} (see Figure 1)	20			20			ns
Data hold time, t_{hold}	0			0			ns
Operating free-air temperature range, T_A	-55		125	0		70	°C

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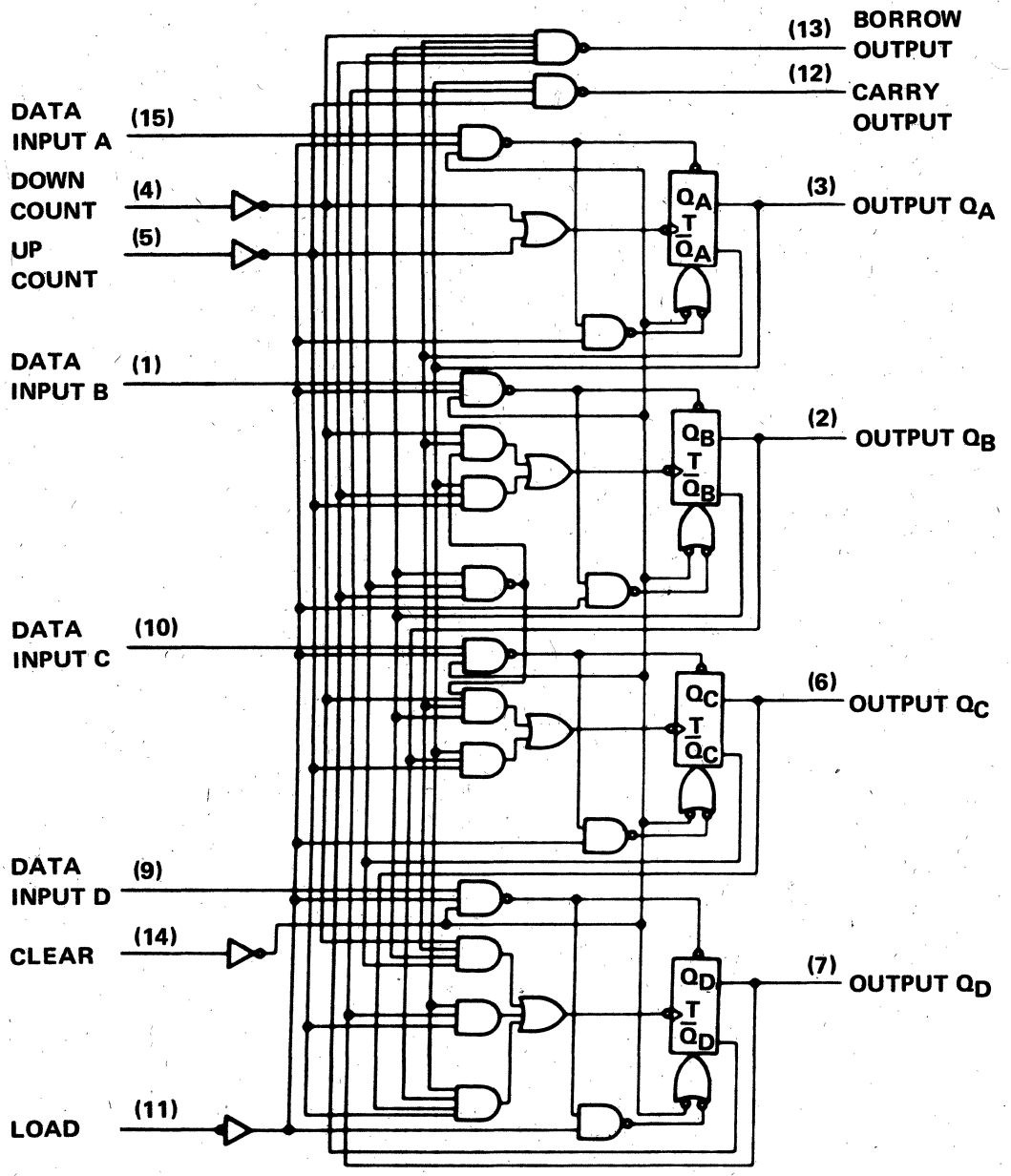
LOGIC DIAGRAM

LS192



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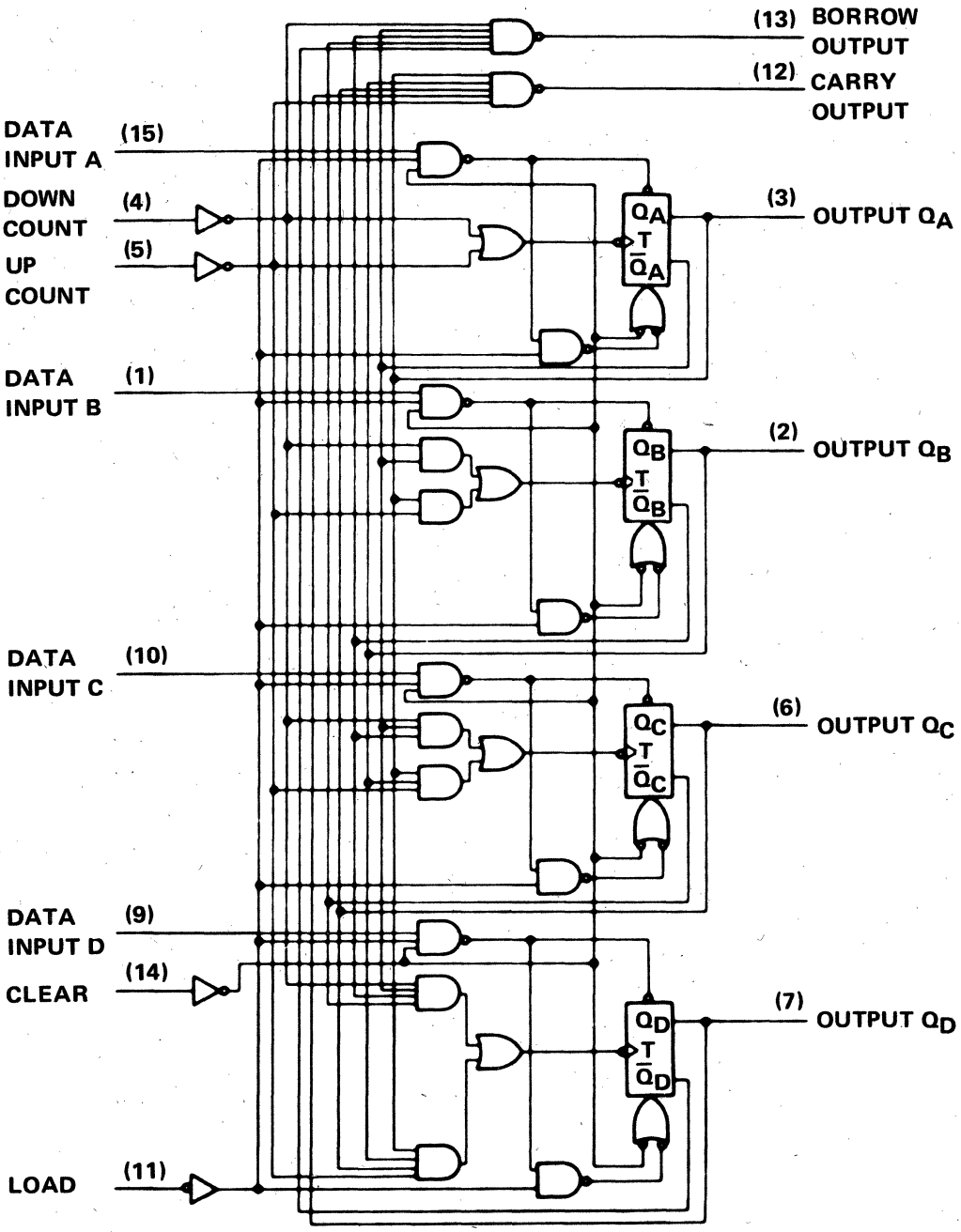
Synchronous BCD Decade Up/Down Counter — LS192

Synchronous 4-Bit Binary Up/Down Counter — LS193

LOGIC DIAGRAM
LS193



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Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-400μA		2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.40		0.25	0.40	V
		I_{OL}=8mA					0.35	0.5	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.4			-0.4	mA
I_{OS}†	V_{CC}=MAX		-15		-100	-15		-100	mA
I_{CC}††	V_{CC}=MAX			19	34		19	34	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
††I_{CC} is measured with all inputs grounded and all outputs open.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter ¶	From (input)	To (output)	−55°C			+25°C			+125°C			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. 1 and 2)												
f_{max}						25	32					MHz
t_{PLH}	Count-up	Carry					17	26				ns
t_{PHL}							16	24				
t_{PLH}	Count-down	Borrow					16	24				ns
t_{PHL}							16	24				
t_{PLH}	Either Count	Q					25	38				ns
t_{PHL}							31	47				
t_{PLH}	Load	Q					27	40				ns
t_{PHL}							29	40				
t_{PHL}	Clear	Q					22	35				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. 1 and 2)												
f_{max}												MHz
t_{PLH}	Count-up	Carry										ns
t_{PHL}												
t_{PLH}	Count-down	Borrow										ns
t_{PHL}												
t_{PLH}	Either Count	Q										ns
t_{PHL}												
t_{PLH}	Load	Q										ns
t_{PHL}												
t_{PHL}	Clear	Q										ns
Test Conditions: C_L = 50pF, R_L = 2kΩ												

¶ f_{max} = maximum clock frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output

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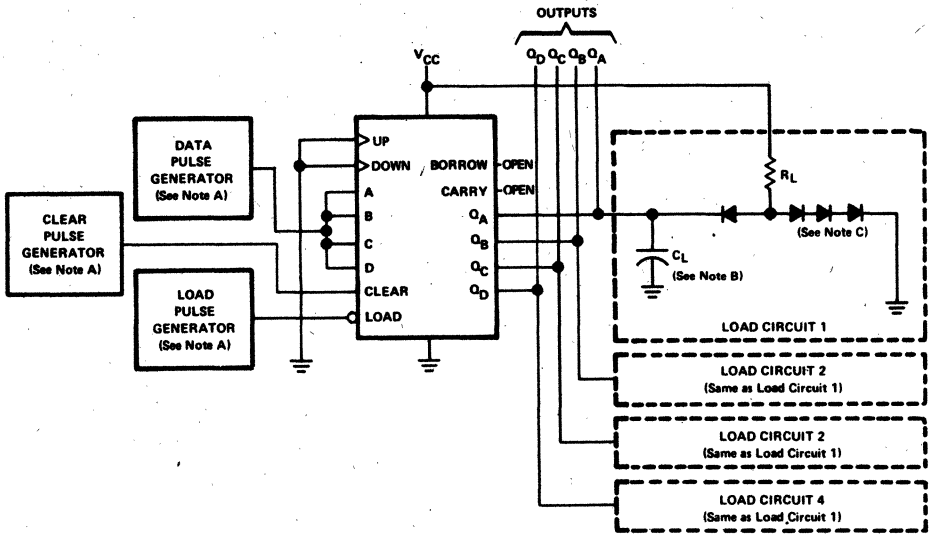
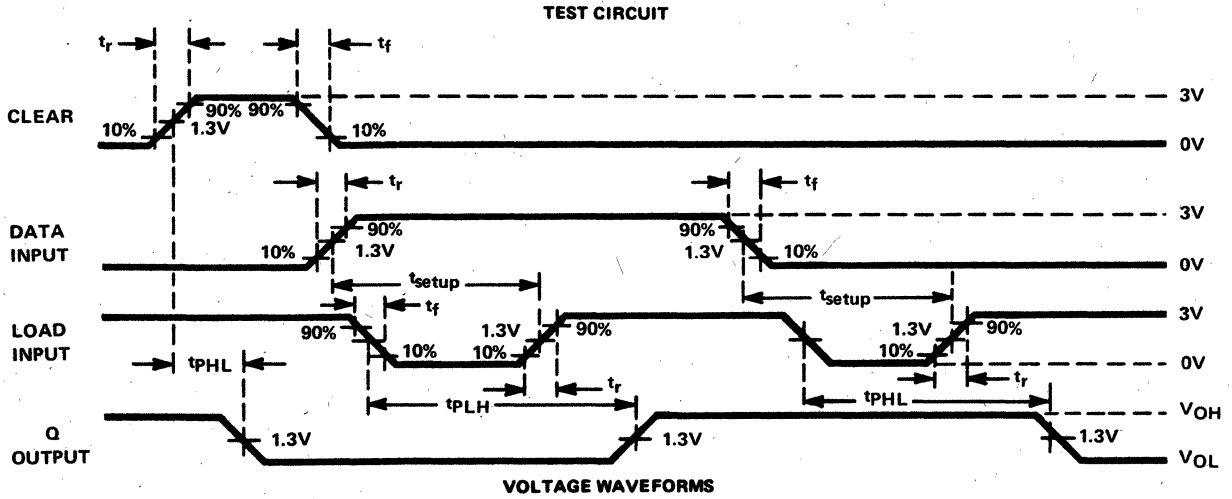
Synchronous BCD Decade Up/Down Counter — LS192
Synchronous 4-Bit Binary Up/Down Counter — LS193

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES:

A. The pulse generators have the following characteristics: Z_{out} = 50Ω and for the data pulse generator PRR < 500KHz, duty cycle = 50%; for the load pulse generator PRR is two times data PRR, duty cycle = 50%.
B. C_L includes probe and jig capacitance.
C. Diodes are 1N3064.
D. t_r and $t_f \leq 7$ ns.

FIGURE 1 — CLEAR, SETUP, AND LOAD TIMES

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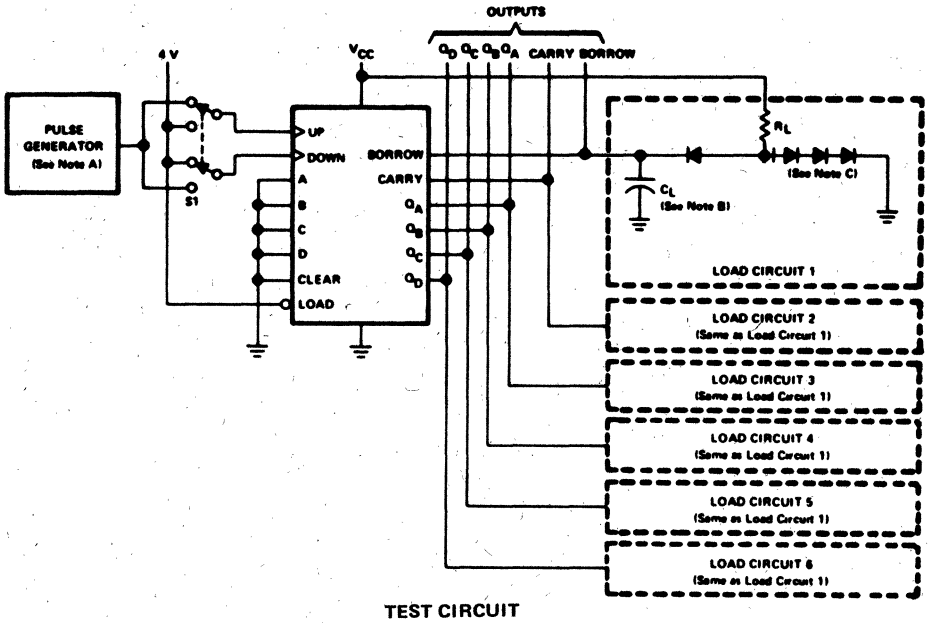
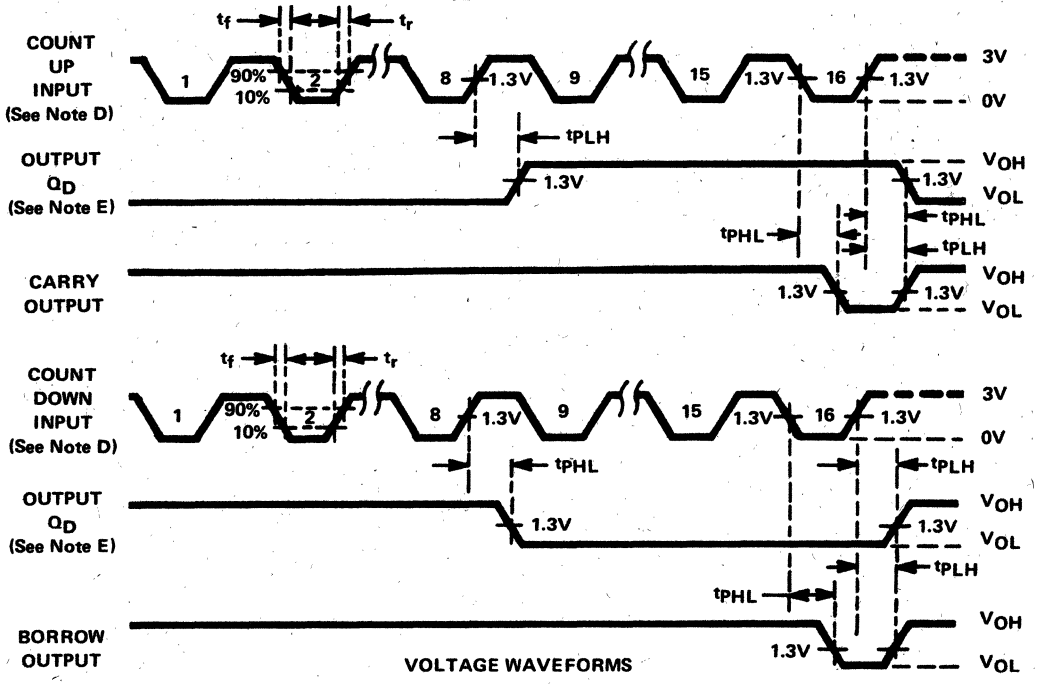
PARAMETER MEASUREMENT INFORMATION (Continued)



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES:

A. The pulse generator has the following characteristics: PRR ≤ 1MHz, Z_{out} = 50Ω, duty cycle = 50%.
B. C_L includes probe and jig capacitance.
C. Diodes are 1N3064.
D. Count-up and count-down pulse shown is for the LS193 binary counter. Count cycle for LS192 decade counter is 1 through 10.
E. Waveforms for outputs Q_A, Q_B, and Q_C are omitted to simplify the drawing.
F. t_r and t_f ≤ 7ns.

FIGURE 2–PROPAGATION DELAY TIMES

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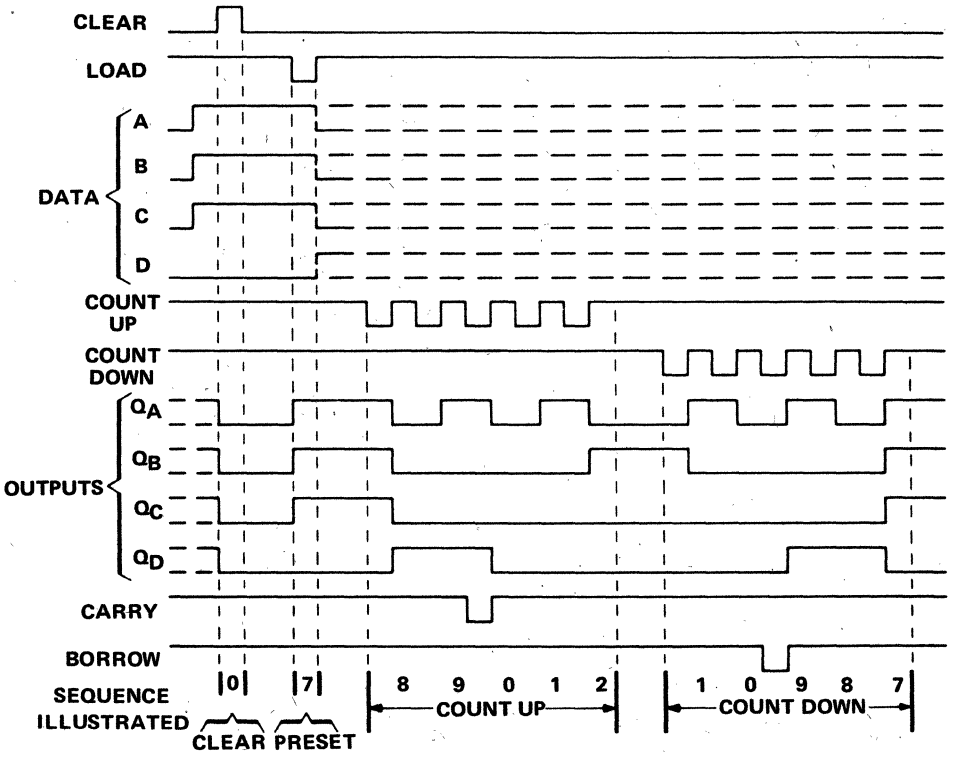
Synchronous BCD Decade Up/Down Counter — LS192
Synchronous 4-Bit Binary Up/Down Counter — LS193

TYPICAL CLEAR, LOAD, AND COUNT SEQUENCES

LS192

Illustrated below is the following sequence:

1. Clear outputs to zero.
2. Load (preset) to BCD seven.
3. Count up to eight, nine, carry, zero, one, and two.
4. Count down to one, zero, borrow, nine, eight, and seven.



NOTES:
A. Clear overrides load, data, and count inputs.
B. When counting up, count-down input must be high; when counting down, count-up input must be high.

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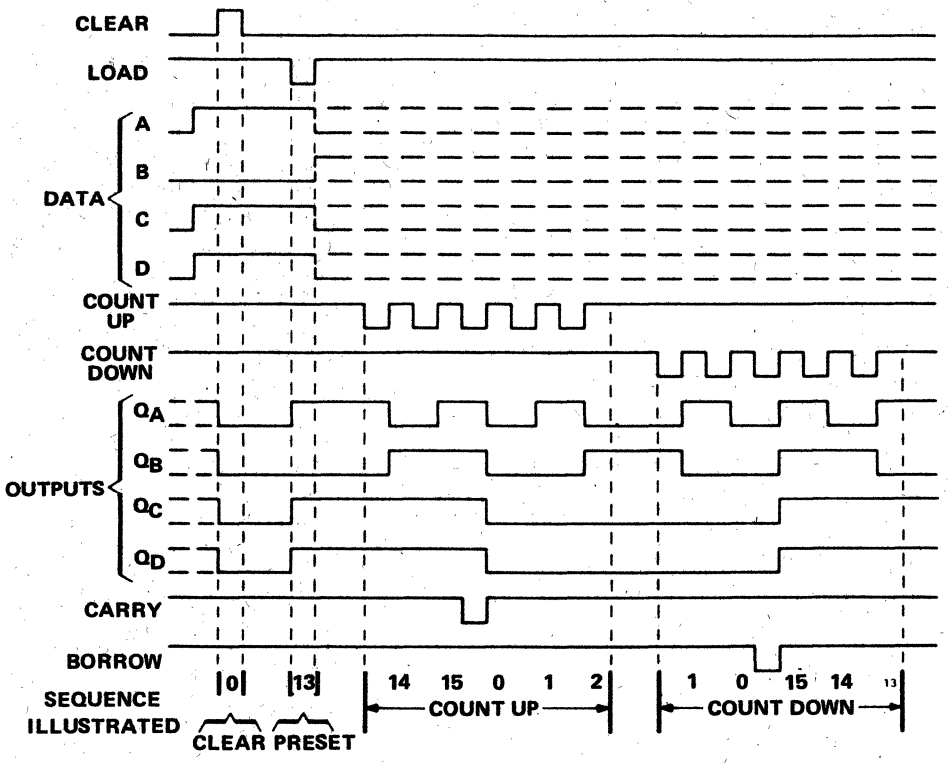
TYPICAL CLEAR, LOAD, AND COUNT SEQUENCES

LS193

Illustrated below is the following sequence:

1. Clear outputs to zero.
2. Load (preset) to binary thirteen.
3. Count up to fourteen, fifteen, carry, zero, one, and two.
4. Count down to one, zero, borrow, fifteen, fourteen, and thirteen.



NOTES:
A. Clear overrides load, data, and count inputs.
B. When counting up, count-down input must be high; when counting down, count-up input must be high.

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4-Bit Universal Shift Register

LS194A

DESCRIPTION

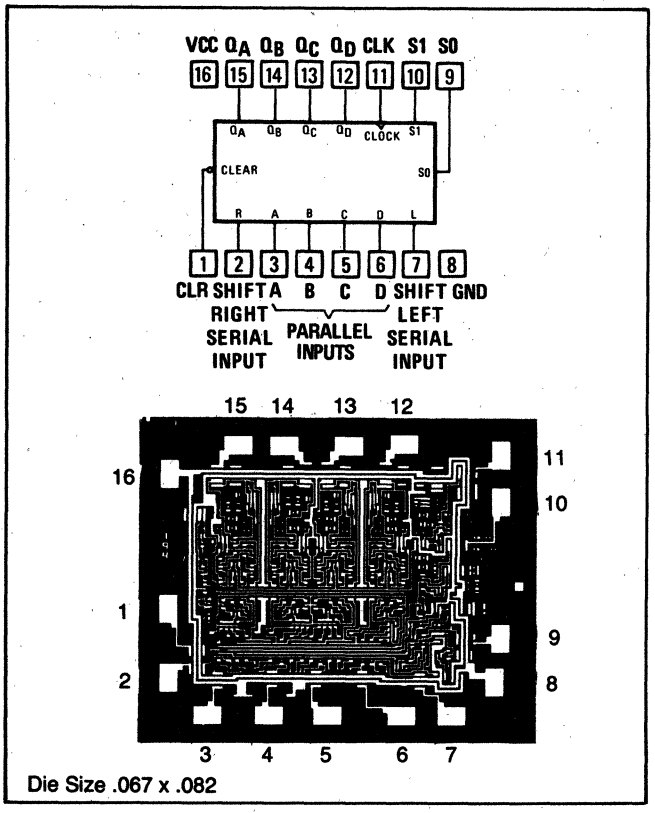
This bidirectional shift register is designed to incorporate virtually all of the features a system designer may want in a shift register. The circuit contains 46 equivalent gates and features parallel inputs, parallel outputs, right-shift and left-shift inputs, operating-mode-control inputs, and a direct over-riding clear line. The register has four distinct modes of operation, namely:

Parallel (broadside) load
Shift right (in the direction Q_A toward Q_D)
Shift left (in the direction Q_D toward Q_A)
Inhibit clock (do nothing)

Synchronous parallel loading is accomplished by applying the four bits of data and taking both mode control inputs, S0 and S1, high. The data are loaded into the associated flip-flops and appear at the outputs after the positive transition of the clock input. During loading, serial data flow is inhibited.

Shift right is accomplished synchronously with the rising edge of the clock pulse when S0 is high and S1 is low. Serial data for this mode is entered at the shift-right data input. When S0 is low and S1 is high, data shifts left synchronously and new data is entered at the shift-left serial input. Clocking of the flip-flop is inhibited when both mode control inputs are low.

PIN-OUT DIAGRAM



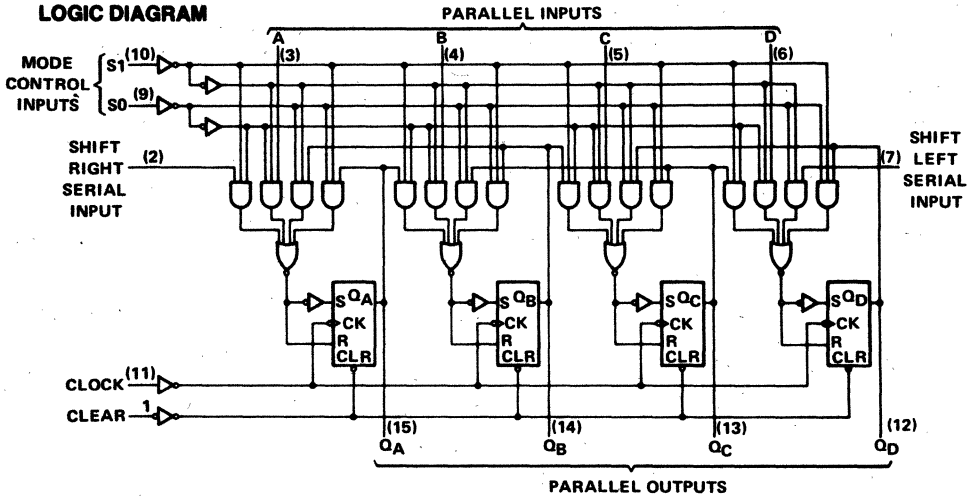
Die Size .067 x .082

FUNCTION TABLE

INPUTS										OUTPUTS			
CLEAR	MODE		CLOCK	SERIAL		PARALLEL				Q_A	Q_B	Q_C	Q_D
	S1	S0		LEFT	RIGHT	A	B	C	D				
L	X	X	X	X	X	X	X	X	X	L	L	L	L
H	X	X	L	X	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
H	H	H	↑	X	X	a	b	c	d	a	b	c	d
H	L	H	↑	X	H	X	X	X	X	H	Q_{An}	Q_{Bn}	Q_{Cn}
H	L	H	↑	X	L	X	X	X	X	L	Q_{An}	Q_{Bn}	Q_{Cn}
H	H	L	↑	H	X	X	X	X	X	Q_{Bn}	Q_{Cn}	Q_{Dn}	H
H	H	L	↑	L	X	X	X	X	X	Q_{Bn}	Q_{Cn}	Q_{Dn}	L
H	L	L	X	X	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}

H = high level (steady state)
L = low level (steady state)
X = irrelevant (any input, including transitions)
↑ = transition from low to high level
a, b, c, d = the level of steady-state input at inputs A, B, C, or D, respectively.
Q_{A0}, Q_{B0}, Q_{C0}, $2Q_{D0}$ = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the indicated steady-state input conditions were established.
Q_{An}, Q_{Bn}, Q_{Cn}, Q_{Dn} = the level of Q_A, Q_B, Q_C, respectively, before the most-recent ↑ transition of the clock.

LOGIC DIAGRAM



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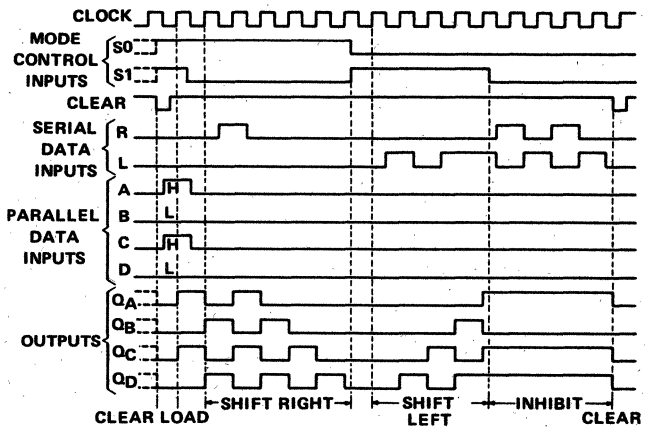
TYPICAL TIMING SEQUENCES



Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}				-400			-400	μA
Low-level output current, I_{OL}				4			8	mA
Clock frequency, f_{clock}		0		30	0		30	MHz
Width of clock or clear pulse, t_w		30			30			ns
Setup time, t_{setup}	Mode control	30			30			ns
	Serial and parallel data	16			16			ns
	Clear inactive-state	18			18			ns
Hold time at any input, t_{hold}		0			0			ns
Operating free-air temperature, T_A		-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-400μA		2.5	3.5		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.40		0.25	0.40	V
		I_{OL}=8mA					0.35	0.50	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.4			-0.36	mA
I_{OS}†	V_{CC}=MAX		-15		-100	-15		-100	mA
I_{CC}††	V_{CC}=MAX			15	23		12	23	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

††With all outputs open, inputs A through D grounded, and 4.5V applied to S0, S1, clear, and the serial inputs, I_{CC} is tested with a momentary GND, then 4.5V, applied to clock.

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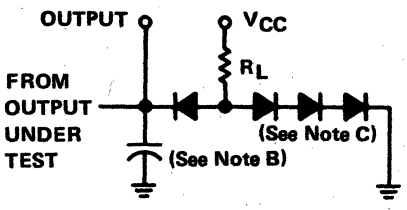
4-Bit Universal Shift Register

LS194A

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	−55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. below)										
f_{max}				30	40					MHz
t_{PHL}					24	30				ns
t_{PLH}					11	18				ns
t_{PHL}					15	22				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. below)										
f_{max}										MHz
t_{PHL}										ns
t_{PLH}										ns
t_{PHL}										ns

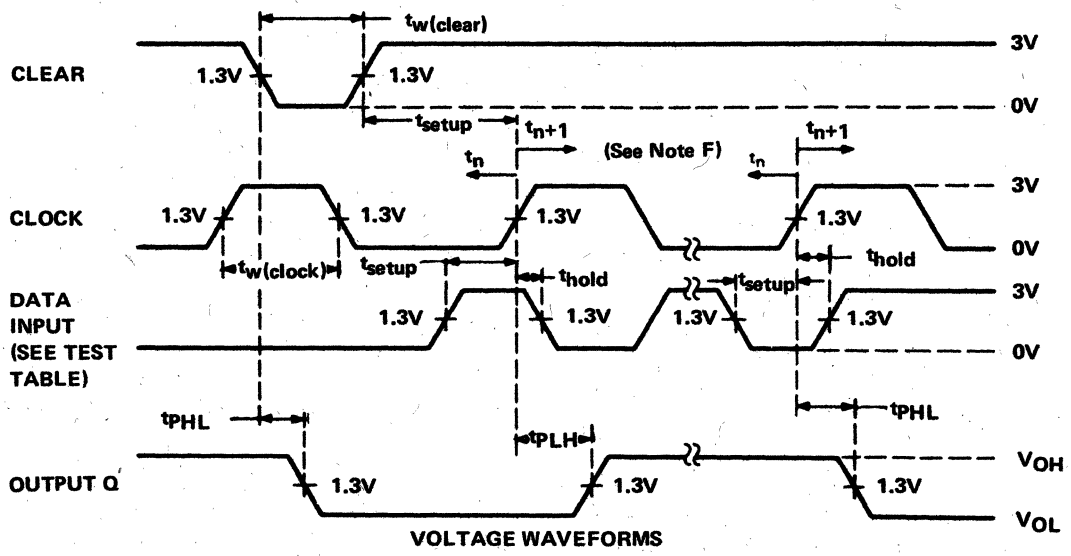
PARAMETER MEASUREMENT INFORMATION



LOAD FOR OUTPUT UNDER TEST

TEST TABLE FOR SYNCHRONOUS INPUTS

DATA INPUT FOR TEST	S1	S0	OUTPUT TESTED (SEE NOTE E)
A	4.5 V	4.5 V	Q_A at t_{n+1}
B	4.5 V	4.5 V	Q_B at t_{n+1}
C	4.5 V	4.5 V	Q_C at t_{n+1}
D	4.5 V	4.5 V	Q_D at t_{n+1}
L Serial Input	4.5 V	0 V	Q_A at t_{n+4}
R Serial Input	0 V	4.5 V	Q_D at t_{n+4}



VOLTAGE WAVEFORMS

NOTES:

A. The clock pulse generator has the following characteristics: $Z_{out} \approx 50\Omega$ and PRR ≤ 1 MHz, $t_r \leq 15$ ns and $t_f \leq 6$ ns. When testing f_{max}, vary PRR.

B. C_L includes probe and jig capacitance.

C. All diodes are 1N3064 or 1N916.

D. A clear pulse is applied prior to each test.

E. Proplagation delay times (t_{PLH} and t_{PHL}) are measured at t_{n+1}. Proper shifting of data is verified at t_{n+4} with a functional test.

F. t_n = bit time before clocking transition.
t_{n+1} = bit time after one clocking transition.
t_{n+4} = bit time after four clocking transitions.

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4-Bit Parallel-Access Shift Register

DESCRIPTION

This 4-bit register features parallel inputs, parallel outputs, J-$\overline{K}$ serial inputs, shift/load control input, and a direct overriding clear. All inputs are buffered to lower the input drive requirements. The register has two modes of operation:

Parallel (broadside) load

Shift (in the direction Q_A toward Q_D)

Parallel loading is accomplished by applying the four bits of data and taking the shift/load control input low. The data is loaded into the associated flip-flop and appears at the outputs after the positive transition of the clock input. During loading, serial data flow is inhibited.

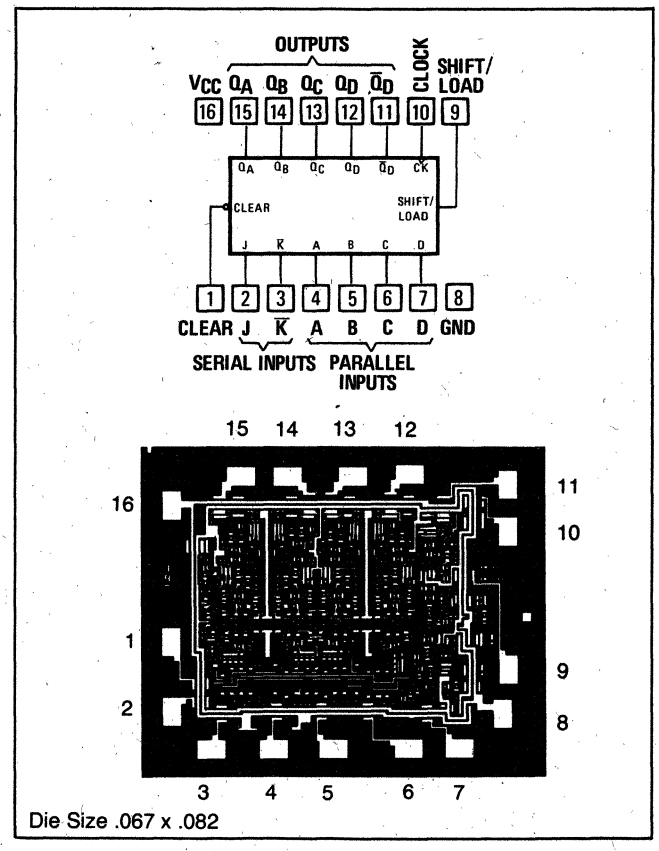
Shifting is accomplished synchronously when the shift/load control input is high. Serial data for this mode is entered at the J-$\overline{K}$ inputs. These inputs permit the first stage to perform as J-$\overline{K}$, D-, or T-type flip-flop as shown in the function table.

FUNCTION TABLE

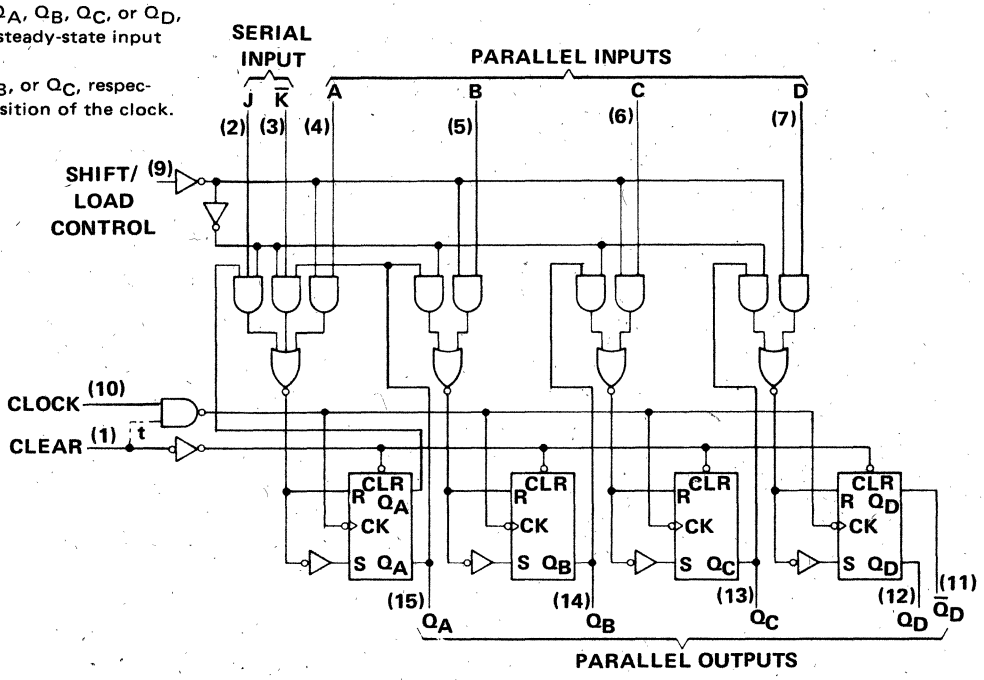
INPUTS									OUTPUTS				
CLEAR	SHIFT/ LOAD	CLOCK	SERIAL		PARALLEL				Q_A	Q_B	Q_C	Q_D	$\overline{Q}_D$
			J	$\overline{K}$	A	B	C	D					
L	X	X	X	X	X	X	X	X	L	L	L	L	H
H	L	↑	X	X	a	b	c	d	a	b	c	d	$\overline{d}$
H	H	L	X	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}	$\overline{Q}_{D0}$
H	H	↑	L	H	X	X	X	X	Q_{A0}	Q_{A0}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$
H	H	↑	L	L	X	X	X	X	L	Q_{An}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$
H	H	↑	H	H	X	X	X	X	H	Q_{An}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$
H	H	↑	H	L	X	X	X	X	$\overline{Q}_{An}$	Q_{An}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$

H = high level (steady state)
L = low level (steady state)
X = irrelevant (any input, including transitions)
↑ = transition from low to high level
a, b, c, d = the level of steady-state input at A, B, C, or D, respectively.
Q_{A0}, Q_{B0}, Q_{C0}, Q_{D0} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the indicated steady-state input conditions were established.
Q_{An}, Q_{Bn}, Q_{Cn} = the level of Q_A, Q_B, or Q_C, respectively, before the most-recent transition of the clock.

PIN-OUT DIAGRAM



LOGIC DIAGRAM



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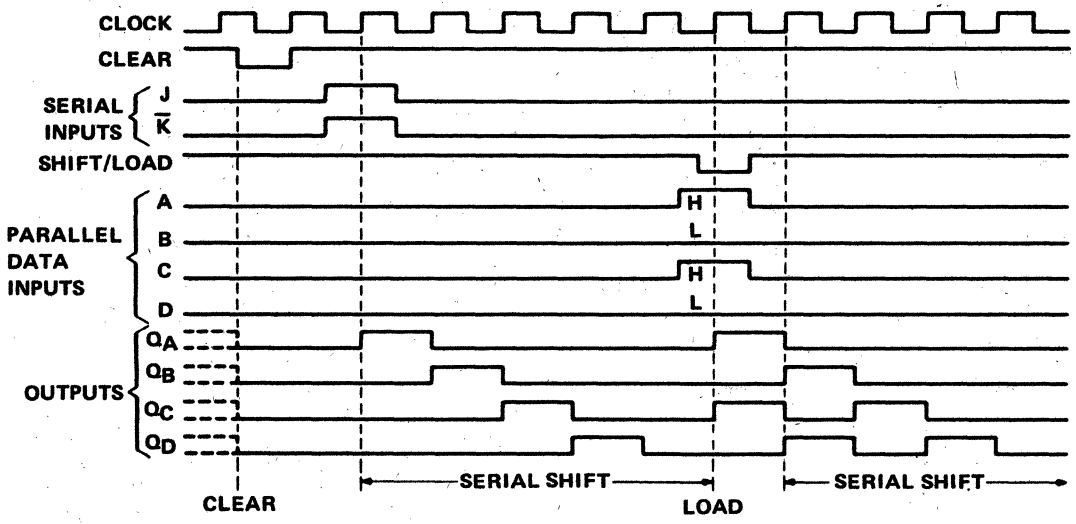
4-Bit Parallel-Access Shift Register

LS195A

TYPICAL TIMING SEQUENCES



Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}				–400			–400	μA
Low-level output current, I_{OL}				4			8	mA
Clock frequency, f_{clock}		0		30	0		30	MHz
Width of clock pulse, $t_{w(clock)}$		18			18			ns
Width of clear input pulse, $t_{w(clear)}$		20			20			ns
Setup time, t_{setup} (see Figure 1)	Shift/load	25			25			ns
	Serial and parallel data	15			15			
	Clear inactive-state	25			25			
Shift/load release time, $t_{release}$ (see Figure 1)				0			0	ns
Serial and parallel data hold time, t_{hold} (see Figure 1)		0			0			ns
Operating free-air temperature, T_A		–55		125	0		70	°C

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	–55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. 1)										
f_{max}				30	40					MHz
t_{PHL} (from clear)		26	23		26	33		35	49	ns
t_{PLH} (from clk)		14	20		14	19		21	31	ns
t_{PHL} (from clk)		20	26		18	24		24	32	ns
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. 1)										
f_{max}										MHz
t_{PHL} (from clear)		27	36		27	36		37	47	ns
t_{PLH} (from clk)		16	22		16	21		24	31	ns
t_{PHL} (from clk)		22	29		21	27		33	46	ns

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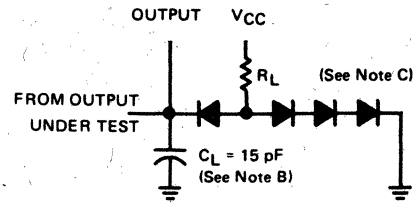
Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-400μA		2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.40		0.25	0.40	V
		I_{OL}=8mA					0.35	0.50	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.4			-0.36	mA
I_{OS}†	V_{CC}=MAX		-15		-100	-15		-100	mA
I_{CC}††	V_{CC}=MAX			14	21		10	17	mA

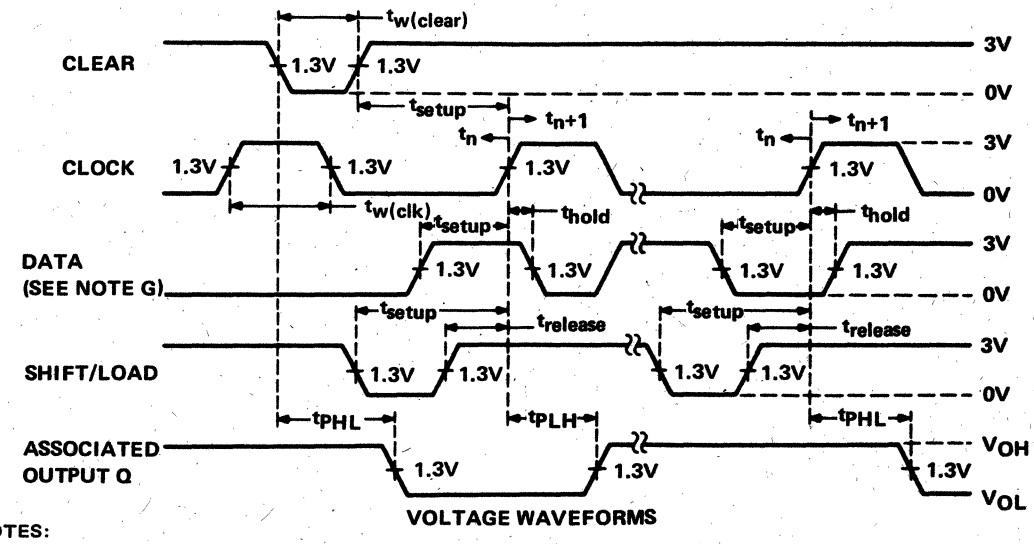
*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
††With all outputs open, shift/load grounded and 4.5V applied to the J, $\overline{K}$, and data inputs, I_{CC} is measured by applying a momentary ground, followed by 4.5V, to clear and then applying a momentary ground, followed by 4.5V to clock.

PARAMETER MEASUREMENT INFORMATION

FIGURE 1



LOAD FOR OUTPUT UNDER TEST



VOLTAGE WAVEFORMS

NOTES:
A. The clock pulse generator has the following characteristics: $Z_{out} \approx 50\ \Omega$ and PRR ⩽ MHz, $t_r \leqslant 15$ ns, and $t_f \leqslant 6$ ns. When testing f_{max}, vary the clock PRR.
B. C_L includes probe and jig capacitance.
C. All diodes are 1N3064.
D. A clear pulse is applied prior to each test.
E. Propagation delay times (t_{PLH} and t_{PHL}) are measured at t_{n+1}. Proper shifting of data is verified at t_{n+4} with a functional test.
F. J and $\overline{K}$ are tested the same as data A, B, C, and D inputs except that shift/load input remains high.
G. t_n = bit time before clocking transition.
t_{n+1} = bit time after one clocking transition.
t_{n+4} = bit time after four clocking transitions.

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Presettable BCD Decade Ripple Counter — LS196

Presettable 4-Bit Binary Ripple Counter — LS197

FEATURES

- BCD, bi-quinary, binary counting modes
- Asynchronous clear
- Fully programmable
- May be used as 4-Bit latches

DESCRIPTION

These high-speed monolithic counters consist of four d-c coupled, master-slave flip-flops which are internally interconnected to provide either a divide-by-two and a divide-by-five counter (LS196) or a divide-by-two and a divide-by-eight counter (LS197). THese four counters are fully programmable; that is, the outputs may be preset to any state by placing a low on the count/load input and entering the desired data at the data inputs. The outputs will change to agree with the data inputs independent of the state of the clocks.

During the count operation, transfer of information to the outputs occurs on the negative-going edge of the clock pulse. These counters feature a direct clear which when taken low sets all outputs low regardless of the states of the clocks.

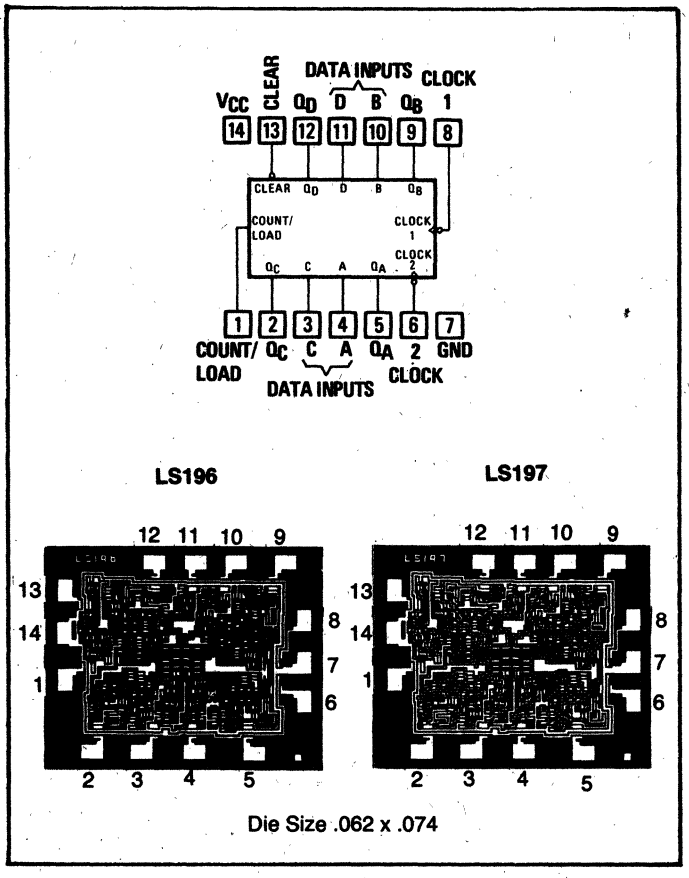
These counters may also be used as 4-bit latches by using the count/load input as the strobe and entering data at the data inputs. The outputs will directly follow the data inputs when the count/load is low, but will remain unchanged when the count/load is high and the clock inputs are inactive.

TYPICAL COUNT CONFIGURATIONS LS196

The output of flip-flop A is not internally connected to the succeeding flip-flops; therefore, the count may be operated in three independent modes:

1. When used as a binary-coded-decimal decade counter, the clock-2 input must be externally connected to the Q_A output. The clock-1 input receives the incoming count, and a count sequence is obtained in accordance with the BCD count sequence function table shown at the right.
2. If a symmetrical divide-by-ten count is desired for frequency synthesizers (or other applications requiring division of a binary count by a power of ten), the Q_D output must be externally connected to the clock-1 input. The input count is then applied at the clock-2 input and a divide-by-ten square wave is obtained at output Q_A in accordance with the bi-quinary function table.
3. For operation as a divide-by-two counter and a divide-by-five counter, no external interconnections are required. Flip-flop A is used as a binary element for the divide-by-two function. The clock-2 input is used to obtain binary divide-by-five operation at the Q_B, Q_C, and Q_D outputs. In this mode, the two counters operate independently; however, all four flip-flops are loaded and cleared simultaneously.

PIN-OUT DIAGRAM



LS196
FUNCTION TABLES

DECADE (BCD) (See Note A)

COUNT	OUTPUTS			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

BI-QUINARY (5-2) (See Note B)

COUNT	OUTPUTS			
	Q_A	Q_D	Q_C	Q_B
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	H	L	L	L
6	H	L	L	H
7	H	L	H	L
8	H	L	H	H
9	H	H	L	L

H = high level, L = low level

NOTES: A. Output Q_A connected to clock-2 input.
B. Output Q_D connected to clock-1 input.

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LS197

The output of flip-flop A is not internally connected to the succeeding flip-flops, therefore the counter may be operated in two independent modes:

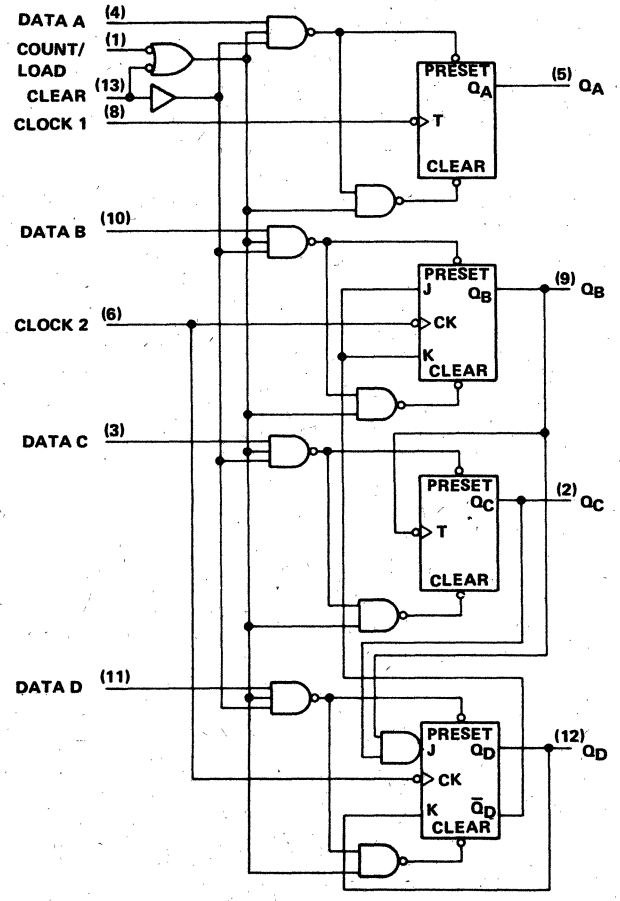
1. When used as a high-speed 4-bit ripple-through counter, output Q_A must be externally connected to the clock-2 input. The input count pulses are applied to the clock-1 input. Simultaneous divisions by 2, 4, 8, and 16 are performed at the Q_A, Q_B, Q_C, Q_D output as shown in the function table at right.
2. When used as a 3-bit ripple-through counter, the input count pulses are applied to the clock-2 input. Simultaneous frequency divisions by 2, 4, and 8 are available at the Q_B, Q_C, and Q_D outputs. Independent use of flip-flop A is available if the load and clear functions coincide with those of the 3-bit-ripple-through counter.

LS197 FUNCTION TABLE
(See Note A)

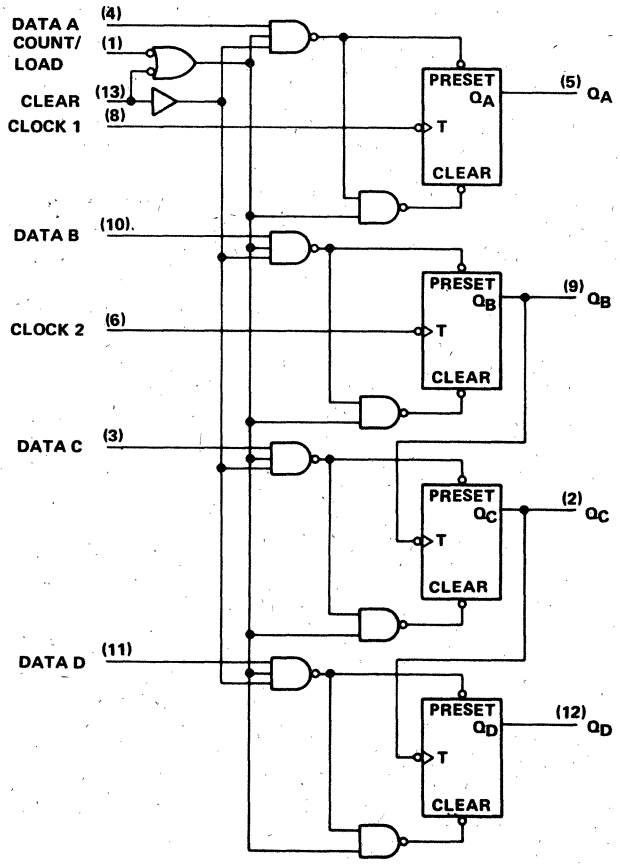
COUNT	OUTPUTS			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H
10	H	L	H	L
11	H	L	H	H
12	H	H	L	L
13	H	H	L	H
14	H	H	H	L
15	H	H	H	H

H = high level, L = low level
NOTE A: Output Q_A connected to clock-2 input.

LOGIC DIAGRAM LS196



LOGIC DIAGRAM LS197



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Presettable BCD Decade Ripple Counter — LS196

Presettable 4-Bit Binary Ripple Counter — LS197

Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.75	V
High-level output current, I_{OH}				-400			-400	μA
Low-level output current, I_{OL}				4			8	mA
Count frequency	Clock-1 input	0			0			MHz
	Clock-2 input	0			0			
Pulse width, t_w	Clock-1 input	20			20			ns
	Clock-2 input	30			30			
	Clear	15			15			
	Load	20			20			
Input hold time, t_{hold}	High-level data	$t_{w\,(load)}$						ns
	Low-level data	$t_{w\,(load)}$						
Input setup time, t_{setup}	High-level data	10			10			ns
	Low-level data	15			15			
Count enable time, t_{enable} (see Note 1)		20			20			ns
Operating free-air temperature, T_A		-55		125	0		70	°C

NOTE1:
Count enable time is the interval immediately preceding the negative-going edge of the clock pulse during which interval the count/load and clear inputs must both be high to ensure counting.

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS			9LS/74LS			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I= -18mA				-1.5			-1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}= -400μA			2.5	3.4		2.7	3.4	V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL} max	I_{OL}=4mA¶		0.25	0.40		0.25	0.40	V
			I_{OL}=8mA					0.35	0.50	
I_I	Data, count/load	V_{CC}=MAX, V_I=7.0V				0.1			0.1	mA
	Clear, clock 1					0.2			0.2	
	Clock 2 of LS196					0.4			0.4	
	Clock 2 of LS197					0.2			0.2	
I_{IH}	Data, count/load	V_{CC}=MAX, V_I=2.7V				20			20	μA
	Clear, clock 1					40			40	
	Clock 2 of LS196					80			80	
	Clock 2 of LS197					40			40	
I_{IL}	Data, count/load	V_{CC}=MAX, V_I=0.4V				-0.36			-0.36	mA
	Clear					-0.72			-0.72	
	Clock 1					-2.4			-2.4	
	Clock 2 of LS196					-2.8			-2.8	
	Clock 2 of LS197					-1.3			-1.3	
I_{OS}†		V_{CC}=MAX		-6		-100	-15		-100	mA
I_{CC}††		V_{CC}=MAX			12	20		12	20	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
¶Q_A outputs are tested at specified I_{OL} plus the limit value of I_{IL} for the clock-2 input. This permits driving the clock-2 input while maintaining full fan-out capability.
††I_{CC} is measured with all inputs grounded and all outputs open.

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Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter		From (input)	To (output)	−55°C			+25°C			+125°C			Unit
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A on page 2-147)													
f_{max}	LS196	Clock 1	Q_A				45	70					MHz
f_{max}	LS197	Clock 1	Q_A				45	60					MHz
t_{PLH}	LS196	Clock 1	Q_A					8	12				ns
t_{PHL}								12	16				
t_{PLH}	LS197	Clock 1	Q_A					8	12				ns
t_{PHL}								12	16				
t_{PLH}	LS196	Clock 2	Q_B					11	15				ns
t_{PHL}								14	19				
t_{PLH}	LS197	Clock 2	Q_B					10	15				ns
t_{PHL}								13	18				
t_{PLH}	LS196	Clock 2	Q_C					22	34				ns
t_{PHL}								29	40				
t_{PLH}	LS197	Clock 2	Q_C					22	34				ns
t_{PHL}								26	34				
t_{PLH}	LS196	Clock 2	Q_D					11	18				ns
t_{PHL}								16	20				
t_{PLH}	LS197	Clock 2	Q_D					34	50				ns
t_{PHL}								40	55				
t_{PLH}	LS196	A, B, C, D	Q_A, Q_B, Q_C, Q_D					12	18				ns
t_{PHL}								21	34				
t_{PLH}	LS197	A, B, C, D	Q_A, Q_B, Q_C, Q_D					21	18				ns
t_{PHL}								21	34				
t_{PLH}	LS196	Load	Any					20	30				ns
t_{PHL}								31	45				
t_{PLH}	LS197	Load	Any					20	30				ns
t_{PHL}								31	45				
t_{PHL}	LS196	Clear	Any					32	45				ns
t_{PHL}	LS197	Clear	Any					32	45				ns

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8-Line-To-1-Line Multiplexer With Three-State Outputs

LS251

FEATURES

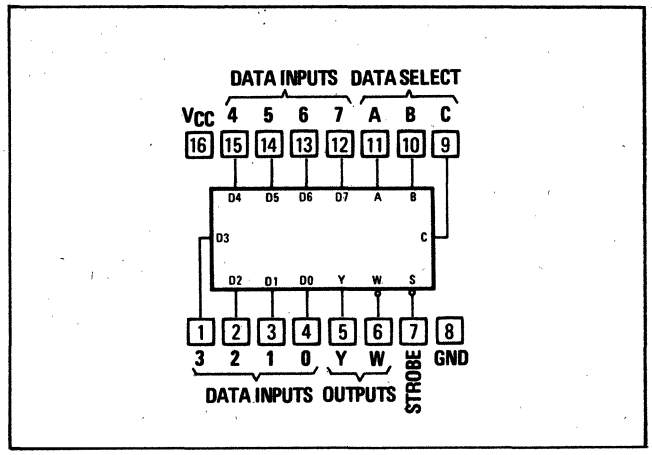
- Selects one of eight data sources
- Performs parallel-to-serial conversion
- Complementary 3-state outputs

DESCRIPTION

This monolithic data selector/multiplexer contains full on-chip binary decoding to select one-of-eight data sources and features a strobe-controlled three-state output. The strobe must be at a low logic level to enable this device. The three-state outputs permit a number of outputs to be connected to a common bus. When the strobe input is high, both outputs are in a high-impedance state in which both the upper and lower transistors of each totem-pole output are off, and the output neither drives nor loads the bus significantly. When the strobe is low, the outputs are activated and operate as standard TTL totem-pole outputs.

To minimize the possibility that two outputs will attempt to take a common bus to opposite logic levels, the output control circuitry is designed so that the average output disable time is shorter than the average output enable time.

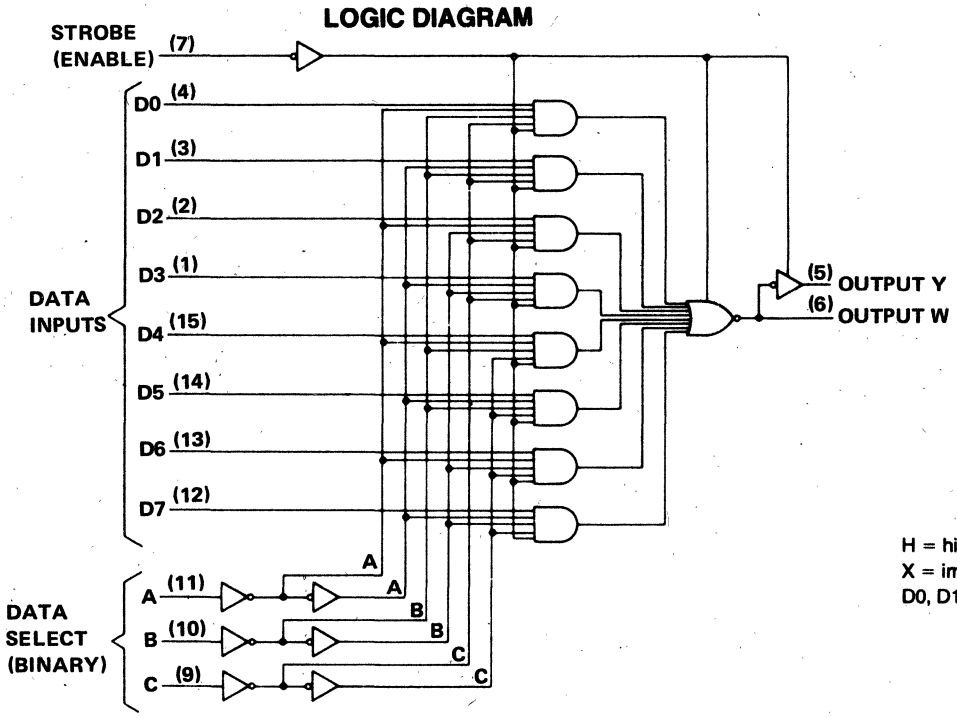
PIN-OUT DIAGRAM



Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-1			-2.6	mA
Low-level output current, I_{OL}			8			8	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

LOGIC DIAGRAM



FUNCTION TABLE

INPUTS				OUTPUTS	
SELECT			STROBE		
C	B	A	S	Y	W
X	X	X	H	Z	Z
L	L	L	L	D0	$\overline{D0}$
L	L	H	L	D1	$\overline{D1}$
L	H	L	L	D2	$\overline{D2}$
L	H	H	L	D3	$\overline{D3}$
H	L	L	L	D4	$\overline{D4}$
H	L	H	L	D5	$\overline{D5}$
H	H	L	L	D6	$\overline{D6}$
H	H	H	L	D7	$\overline{D7}$

H = high logic level, L = low logic level
X = irrelevant, Z = high impedance (off)
D0, D1 . . . D7 = the level of the respective D input

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Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=MAX, I_{OH}=MAX		2.4	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=MAX,	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
$I_{O(off)}$	V_{CC}=MAX, V_{IH}=2V	V_O=2.7V			20			20	μA
		V_O=0.4V			-20			-20	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.4			-0.4	mA
I_{OS}†	V_{CC}=MAX		-15		-100	-15		-100	mA
I_{CC}††	V_{CC}=MAX	Condition A		6.1	10		6.1	10	mA
		Condition B		7.1	12		7.1	12	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

††I_{CC} is measured with the outputs open and all data and select inputs at 4.5V under the following conditions:

A. Strobe grounded.
B. Strobe at 4.5V

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter ¶	From (Input)	To (output)	−55°C			+25°C			+125°C			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. C on page 2-147)												
t_{PLH}	A, B, or C (4 levels)	Y					29	45				ns
t_{PHL}							28	45				
t_{PLH}	A, B, or C (3 levels)	W					20	33				ns
t_{PHL}							21	33				
t_{PLH}	Any D	Y					17	28				ns
t_{PHL}							18	28				
t_{PLH}	Any D	W					10	15				ns
t_{PHL}							9	15				
t_{ZH}	Strobe	Y					17	27				ns
t_{ZL}							26	40				
t_{ZH}	Strobe	W					17	27				ns
t_{ZL}							24	40				
Test Conditions: C_L = 5pF, R_L = 2kΩ (See Fig. C on page 2-147)												
t_{HZ}	Strobe	Y					30	45				ns
t_{LZ}							15	25				
t_{HZ}	Strobe	W					30	45				ns
t_{LZ}							15	25				

¶t_{PLH} = propagation delay time, low-to-high-level output.
t_{PHL} = propagation delay time, high-to-low-level output.
t_{ZH} = output enable time to high level.
t_{ZL} = output enable time to low level.
t_{HZ} = output disable time from high level.
t_{LZ} = output disable time from low level.

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Dual 4-Line-To-1-Line Multiplexer With Three-State Outputs

LS253

FEATURES

- Three-state version of LS153
- Non-inverting
- Permits multiplexing from N lines to 1 line
- Performs parallel-to-serial conversion

DESCRIPTION

The LS253 is a high-speed dual 4-line-to-1-line multiplexer with common select inputs and separate output control inputs for each half. Each half can select one bit of four and present it at the output in non-inverted form.

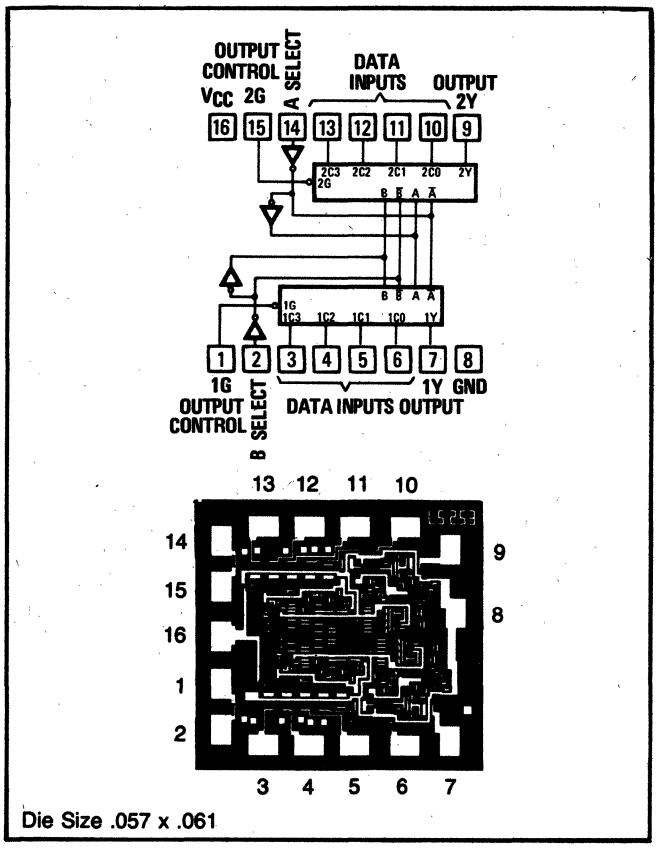
The three-state outputs can interface with and drive data lines of bus-organized systems. With all but one of the common outputs disabled (at a high-impedance state) the low-impedance of the single enabled output will drive the bus line to a high or low logic level.

FUNCTION TABLE

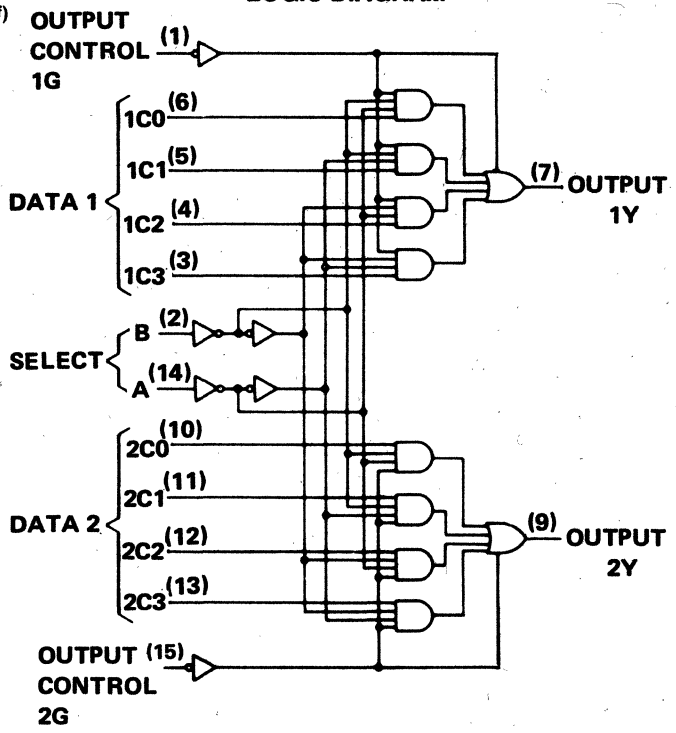
SELECT INPUTS		DATA INPUTS				OUTPUT CONTROL	OUTPUT
B	A	C0	C1	C2	C3	G	Y
X	X	X	X	X	X	H	Z
L	L	L	X	X	X	L	L
L	L	H	X	X	X	L	H
L	H	X	L	X	X	L	L
L	H	X	H	X	X	L	H
H	L	X	X	L	X	L	L
H	L	X	X	H	X	L	H
H	H	X	X	X	L	L	L
H	H	X	X	X	H	L	H

Address inputs A and B are common to both sections.
H = high level, L = low level, X = irrelevant, Z = high impedance (off)

PIN-OUT DIAGRAM



LOGIC DIAGRAM



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Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-1			-2.6	mA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=MAX		2.4	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.40		0.25	0.40	V
		I_{OL}=8mA					0.35	0.50	
$I_{O(off)}$	V_{CC}=MAX, V_{IH}=2V	V_O=2.7V			20			20	μA
		V_O=0.4V			-20			-20	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.36			-0.36	mA
I_{OS}†	V_{CC}=MAX		-6		-100	-15		-100	mA
I_{CC}††	V_{CC}=MAX	Condition A		7	12		7	12	mA
		Condition B		8.5	14		8.5	14	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

††I_{CC} is measured with the outputs open under the following conditions:

A. All inputs grounded.

B. Output control at 4.5V, all inputs grounded.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter¶	From (Input)	To (output)	−55°C			+25°C			+125°C			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. C on page 2-147)												
t_{PLH}	Data	Y					7	12				ns
t_{PHL}							12	17				
t_{PLH}	Select	Y					18	25				ns
t_{PHL}							18	27				
t_{ZH}	Output Control	Y					10	16				ns
t_{ZL}							13	18				
Test Conditions: C_L = 5pF, R_L = 2kΩ (See Fig. C on page 2-147)												
t_{HZ}	Output Control	Y					7	15				ns
t_{LZ}							12	19				
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. C on page 2-147)												
t_{PLH}	Data	Y					7	12				ns
t_{PHL}							12	17				
t_{PLH}	Select	Y					18	25				ns
t_{PHL}							18	27				
t_{ZH}	Output Control	Y					10	16				ns
t_{ZL}							13	18				

t_{PLH} = propagation delay time, low-to-high-level output

t_{PHL} = propagation delay time, high-to-low-level output

t_{ZH} = Output enable time to high level

t_{ZL} = Output enable time to low level

t_{HZ} = Output disable time from high level

t_{LZ} = Output disable time from low level

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Dual 2-Line-To-4-Line Decoder/Demultiplexer With Three-State Outputs

LS255

FEATURES

- Three-state version of LS155
- Applications:
  - Dual 2-Line-to-4-Line Decoder
  - Dual 1-Line-to-4-Line Demultiplexer
  - 3-Line-to-8-Line Decoder
  - 1-Line-to-8-Line Demultiplexer

DESCRIPTION

The LS255 features dual 1-line-to-4-line demultiplexers with individual strobes and common binary-address inputs in a single 16-pin package. When both sections are enabled by the output controls, the common binary-address inputs sequentially select and route associated input data to the appropriate output of each section. The individual controls permit activating or inhibiting each of the 4-bit sections as desired. Data applied to input 1C is inverted at its outputs and data applied at 2C is not inverted through its outputs. The inverter following the 1C data input permits use as a 3-to-8-line decoder or 1-to-8-line demultiplexer without external gating. Input clamping diodes are provided on all of these circuits to minimize transmission-line effects and simplify system design.

FUNCTION TABLE
3-LINE-TO-8-LINE DECODER
OR 1-LINE-TO-8-LINE DEMULTIPLEXER

INPUTS				OUTPUTS			
SELECT		CONTROL	DATA				
B	A	1G	1C	1Y0	1Y1	1Y2	1Y3
X	X	H	X	z	z	z	z
L	L	L	H	L	H	H	H
L	H	L	H	H	L	H	H
H	L	L	H	H	H	L	H
H	H	L	H	H	H	H	L
X	X	X	L	H	H	H	H

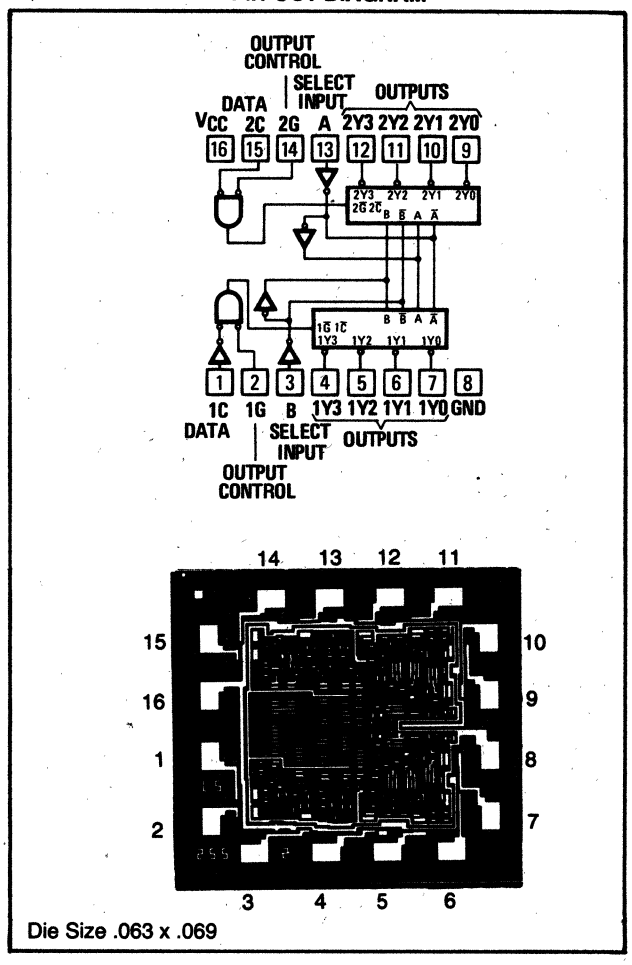
INPUTS				OUTPUTS			
SELECT		CONTROL	DATA				
B	A	2G	2C	2Y0	2Y1	2Y2	2Y3
X	X	H	X	z	z	z	z
L	L	L	L	L	H	H	H
L	H	L	L	H	L	H	H
H	L	L	L	H	H	L	H
H	H	L	L	H	H	H	L
X	X	X	H	H	H	H	H

FUNCTION TABLES
2-LINE-TO-4-LINE DECODER
OR 1-LINE-TO-4-LINE DEMULTIPLEXER

INPUTS				OUTPUTS							
SELECT			CONTROL OR DATA	(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
C†	B	A	G‡	2Y0	2Y1	2Y2	2Y3	1Y0	1Y1	1Y2	1Y3
X	X	X	H	z	z	z	z	z	z	z	z
L	L	L	L	L	H	H	H	H	H	H	H
L	L	H	L	H	L	H	H	H	H	H	H
L	H	L	L	H	H	L	H	H	H	H	H
L	H	H	L	H	H	H	L	H	H	H	H
H	L	L	L	H	H	H	H	L	H	H	H
H	L	H	L	H	H	H	H	H	L	H	H
H	H	L	L	H	H	H	H	H	H	L	H
H	H	H	L	H	H	H	H	H	H	H	L

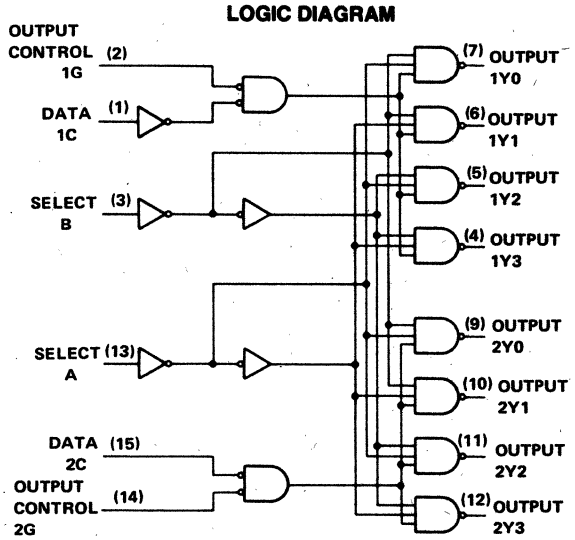
†C = inputs 1C and 2C connected together
‡G = inputs 1G and 2G connected together
H = high level, L = low level, X = irrelevant, Z = high impedance (off)

PIN-OUT DIAGRAM



Die Size .063 x .069

LOGIC DIAGRAM



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Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			−1			−2.6	mA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	−55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=−18mA				−1.5			−1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=MAX		2.4	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
$I_{O(off)}$	V_{CC}=MAX, V_{IH}=2V	V_O=2.7V			20			20	μA
		V_O=0.4V			−20			−20	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				−0.36			−0.36	mA
I_{OS}†	V_{CC}=MAX		−15		−100	−15		−100	mA
I_{CC}††	V_{CC}=MAX	Condition A		6	10		6	10	mA
		Condition B		11	17		11	17	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

NOTE 1:

††I_{CC} is measured with the outputs open under the following conditions:
A. A, B, and 1C inputs at 4.5V, and 2C, 1G, and 2G inputs grounded.
B. Same as Condition A except inputs 1G and 2G at 4.5V.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	From (input)	To (output)	−55°C			+25°C			+125°C			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. C on page 2-147)												
t_{PLH}	A, B, 1C or 2C	Y					13	18				ns
t_{PHL}							16	22				
t_{PLH}	A or B (3 levels)	Y					16	22				ns
t_{PHL}							20	26				
t_{ZH}	Output Control	Y					10	15				ns
t_{ZL}							12	18				
Test Conditions: C_L = 5pF, R_L = 2kΩ (See Fig. C on page 2-147)												
t_{HZ}	Output Control	Y					9	15				ns
t_{LZ}							15	20				

¶t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
t_{ZH} = output enable time to high level
t_{ZL} = output enable time to low level
t_{HZ} = output disable time from high level
t_{LZ} = output disable time from low level

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Quadruple 2-Line-To-1-Line Multiplexers With Three-State Outputs

LS257 LS258

DESCRIPTION

These data selectors/multiplexers select a 4-bit word from one of two sources and present it at the four outputs. The LS257 presents true data; the LS258 presents inverted data. With Output Control HIGH, the outputs are forced to a high impedance state.

FUNCTION TABLE

INPUTS				OUTPUT Y	
OUTPUT CONTROL	SELECT	A	B	LS257	LS258
H	X	X	X	Z	Z
L	L	L	X	L	H
L	L	H	X	H	L
L	H	X	L	L	H
L	H	X	H	H	L

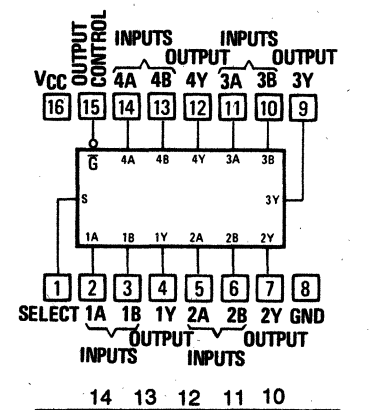
H = high level, L = low level, X = irrelevant, Z = high impedance (off)

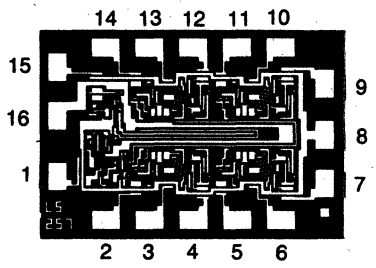
Low level at S selects A inputs.

High level at S selects B inputs.

PIN-OUT DIAGRAMS

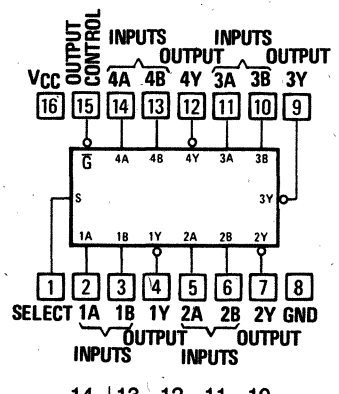
LS257

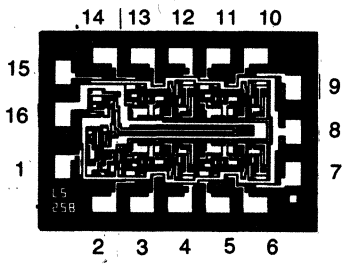




Die Size .047 x .066

LS258





Die Size .047 x .066

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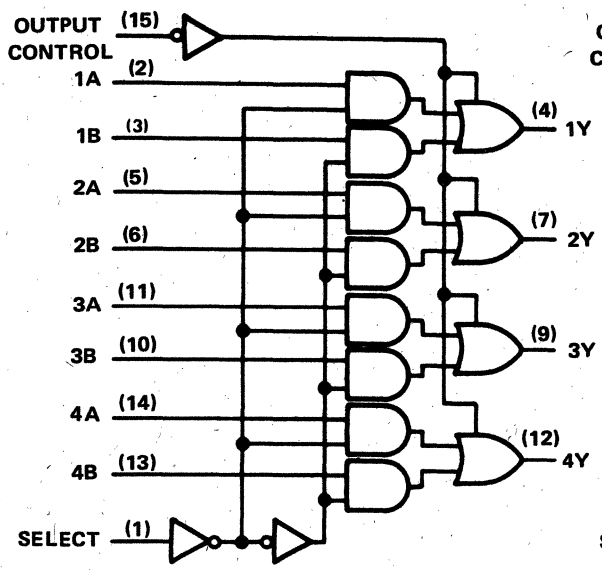
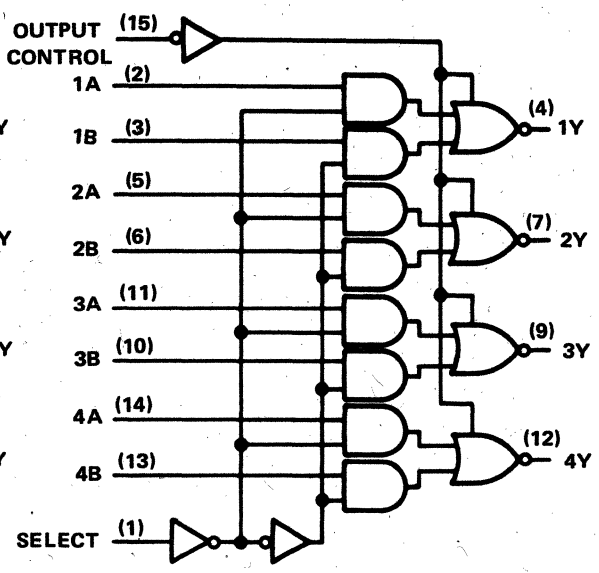
Quadruple 2-Line-To-1-Line Multiplexers With Three-State Outputs

LOGIC DIAGRAMS

LS257



LS258



Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			−1			−2.6	mA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	−55		125	0		70	°C

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter ¶		From (input)	To (output)	−55°C			+25°C			+125°C			Unit
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. C on page 2-147)													
t_{PLH}	LS257	Data	Any					6	12				ns
t_{PHL}								7	12				
t_{PLH}	LS258	Data	Any					8	14				ns
t_{PHL}								5	12				
t_{PLH}	LS257	Select	Any					12	18				ns
t_{PHL}								12	18				
t_{PLH}	LS258	Select	Any					12	18				ns
t_{PHL}								10	18				
t_{ZH}	LS257	Output Control	Any					10	18				ns
t_{ZL}								10	16				
t_{ZH}	LS258	Output Control	Any					10	18				ns
t_{ZL}								11	18				
Test Conditions: C_L = 5pF, R_L = 2kΩ (See Fig. C on page 2-147)													
t_{HZ}	LS257	Output Control	Any					10	15				ns
t_{LZ}								10	18				
t_{HZ}	LS258	Output Control	Any					9	15				ns
t_{LZ}								8	15				

¶ t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
t_{ZH} = output enable time to high level
t_{ZL} = output enable time to low level
t_{HZ} = output disable time from high level
t_{LZ} = output disable time from low level

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Quadruple 2-Line-To-1-Line Multiplexers With Three-State Outputs

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS			9LS/74LS			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL} max, I_{OH}=MAX		2.4	3.4		2.4	3.1		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL} max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
			I_{OL}=8mA					0.35	0.5	
I_{OZH}		V_{CC}=MAX, V_{IH}=2V, V_O=2.4V				20			20	μA
I_{OZL}		V_{CC}=MAX, V_{IH}=2V, V_O=0.4V				-20			-20	μA
I_I	S input	V_{CC}=MAX, V_I=7V				0.2			0.2	mA
	Any other					0.1			0.1	
I_{IH}	S input	V_{CC}=MAX, V_I=2.7V				40			40	μA
	Any other					20			20	
I_{IL}	S input	V_{CC}=MAX, V_I=0.4V				-0.8			-0.8	mA
	Any other					-0.4			-0.4	
I_{OS}†		V_{CC}=MAX		-15		-100	-15	-15	-100	mA
I_{CC}††	All outputs high	V_{CC}=MAX	LS257		5.9	10		5.9	10	mA
	All outputs low				9.2	16		9.2	16	
	All outputs off				10	17		10	17	
	All outputs high		LS258		4.1	7		4.1	7	
	All outputs low				6.2	11		6.2	11	
	All outputs off				7.0	12		7.0	12	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
††I_{CC} is measured with all outputs open and all possible inputs grounded while achieving the stated output conditions.

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FEATURES

- **Fast Multiplication . . . 5-Bit Product in 26ns Typ**
- **Power Dissipation . . . 110mW Typical**
- **Latch Outputs for Synchronous Operation**
- **Expandable for m-Bit-by-n-Bit Applications**
- **Fully Compatible with Most TTL and Other Saturated Low-Level Logic Families**
- **Diode-Clamped Inputs Simplify System Design**

DESCRIPTION

These low-power Schottky circuits are designed to be used in parallel multiplication applications. They perform binary multiplication in two's-complement form, two bits at a time.

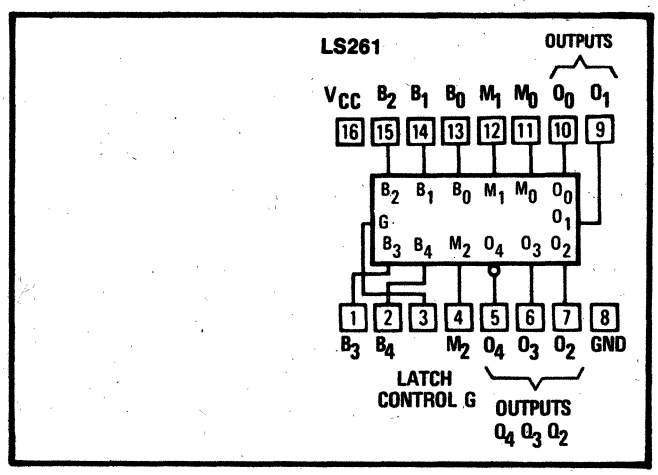
The M inputs are for the multiplier bits and the B inputs are for the multiplicand. The Q outputs represent the partial product as a recoded base-4 number. This recoding effectively reduces the Wallace-tree hardware requirements by a factor of two.

The outputs represent partial products in one's complement form generated as a result of multiplication. A simple rounding scheme using two additional gates is needed for each partial product to generate two's complement.

The leading (most-significant) bit of the product is inverted for ease in extending the sign to square (left justify) the partial-product bits.

The 9LS/54L261 is characterized for operation over the full military temperature range of −55°C to 125°C; the 9LS/74LS261 for operation from 0°C to 70°C.

PIN-OUT DIAGRAM



FUNCTION TABLE

INPUTS				OUTPUTS				
LATCH CONTROL G	MULTIPLIER			$\bar{Q}4$	Q3	Q2	Q1	Q0
	M2	M1	M0					
L	X	X	X	$Q4_0$	$Q3_0$	$Q2_0$	$Q1_0$	$Q0_0$
H	L	L	L	H	L	L	L	L
H	L	L	H	$\bar{B}4$	B4	B3	B2	B1
H	L	H	L	$\bar{B}4$	B4	B3	B2	B1
H	L	H	H	$\bar{B}4$	B3	B2	B1	B0
H	H	L	L	B4	$\bar{B}3$	$\bar{B}2$	$\bar{B}1$	$\bar{B}0$
H	H	L	H	B4	$\bar{B}4$	$\bar{B}3$	$\bar{B}2$	$\bar{B}1$
H	H	H	L	B4	$\bar{B}4$	$\bar{B}3$	$\bar{B}2$	$\bar{B}1$
H	H	H	H	H	L	L	L	L

H = high level, L = low level, X = irrelevant

$\bar{Q}4_0 \ldots Q0_0$ = The logic level of the same output before the high-to-low transition of G.

B4 . . . B0 = The logic level of the indicated multiplicand (B) input

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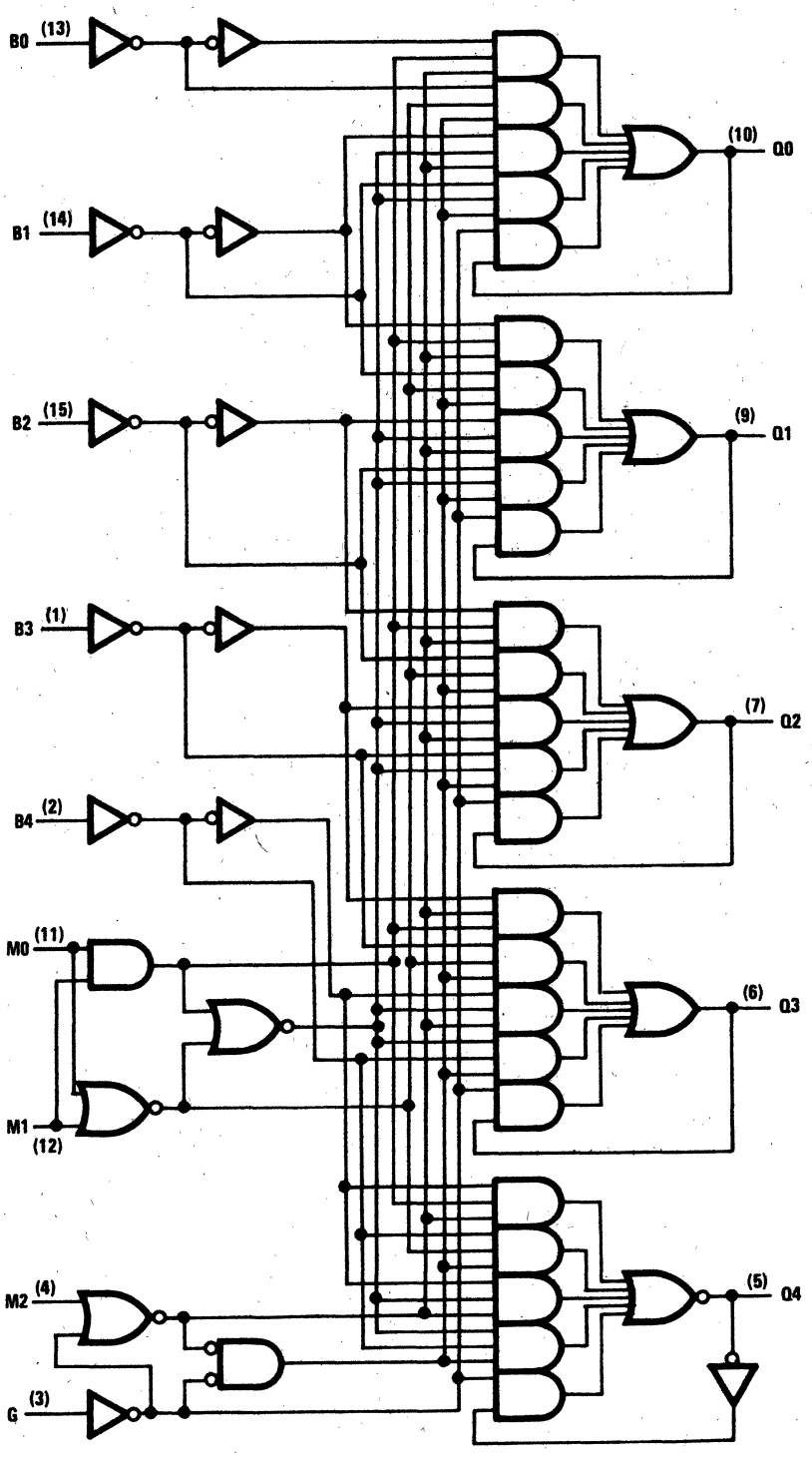
2-Bit By 4-Bit Parallel Binary Multipliers

LOGIC DIAGRAM



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Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}				-1			-1	mA
Low-level output current, I_{OL}				4			8	mA
Width of enable pulse, t_w		25			25			ns
Setup time, t_{setup}	Any M input	17↓			17↓			ns
	Any B input	15↓			15↓			
Hold time, t_{hold}	Any M input	0↓			0↓			ns
	Any B input	0↓			0↓			
Operating free-air temperature, T_A		-55		125	0		70	°C

↓The arrow indicates that the falling edge of the enable pulse is used for reference.

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.2	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-1mA		2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.4			-0.4	mA
I_{OS}†	V_{CC}=MAX		-6		-40	-5		-42	mA
I_{CC}	V_{CC}=MAX, All inputs at 0V, Outputs open			22	38		22	40	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter ¶	From (input)	To (output)	-55°C			+25°C			+125°C			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ												
t_{PLH}	Enable G	Any Q					22	35				ns
t_{PHL}							20	30				
t_{PLH}	Any M input	Any Q					25	40				ns
t_{PHL}							22	35				
t_{PLH}	Any B input	Any Q					27	42				ns
t_{PHL}							24	37				
Test Conditions: C_L = 50pF, R_L = 2kΩ												
t_{PLH}	Enable G	Any Q										ns
t_{PHL}												
t_{PLH}	Any M input	Any Q										ns
t_{PHL}												
t_{PLH}	Any B input	Any Q										ns
t_{PHL}												

¶ t_{PLH} = propagation delay time, low-to-high level outputs.
t_{PHL} = propagation delay time, high-to-low level output.

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4-Bit Bi-Directional Shift Register With Three-State Outputs

LS295A

FEATURES

- **Three-state version of LS95B parallel-access shift register**

DESCRIPTION

This 4-bit register features parallel inputs, parallel outputs, and clock, serial, mode, and output control inputs. The register has three modes of operation:

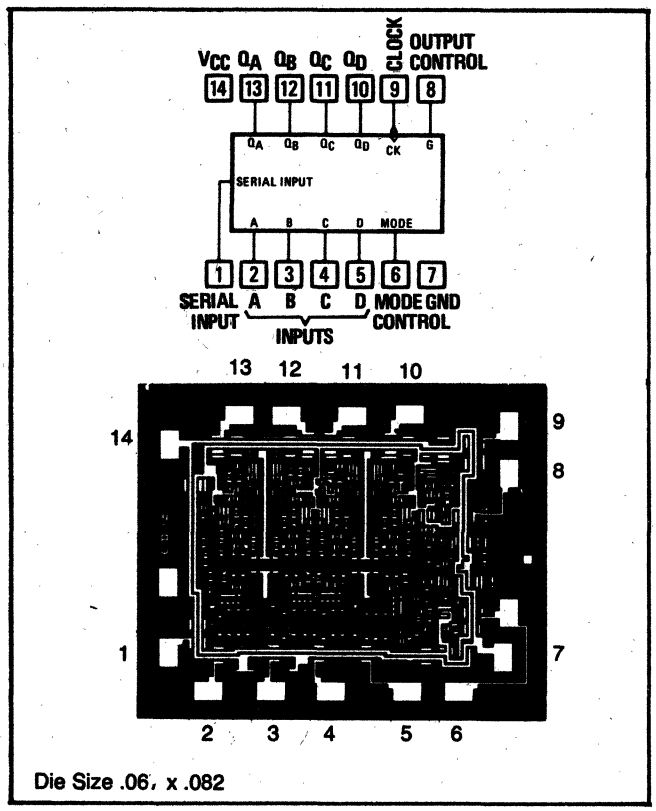
Parallel (broadside) load
Shift right (the direction Q_A toward Q_D)
Shift left (the direction Q_D toward Q_A)

Parallel loading is accomplished by applying the four bits of data and taking the mode control input high. The data is loaded into the associated flip-flops and appears at the outputs after the high-to-low transition of the clock input. During parallel loading, the entry of serial data is inhibited.

Shift right is accomplished when the mode control is low; shift left is accomplished when the mode control is high by connecting the output of each flip-flop to the parallel input of the previous flip-flop (Q_D to input C, etc.) and serial data is entered at input D.

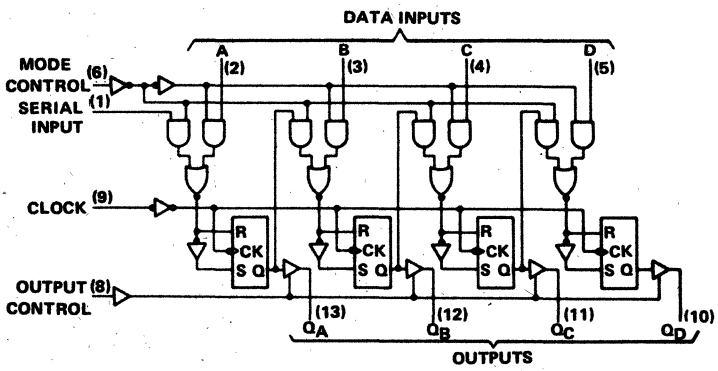
When the output is high, the normal logic levels of the four outputs are available for driving the loads or bus lines. The outputs are disabled independently from the level of the clock by a low logic level at the output control input. The outputs then present a high impedance and neither load nor drive the bus bus line; however, sequential operation of the register is not affected.

PINOUT DIAGRAM



Die Size .06, x .082

LOGIC DIAGRAM



INPUTS							OUTPUTS			
MODE CONTROL	CLOCK	SERIAL	PARALLEL A	B	C	D	Q_A	Q_B	Q_C	Q_D
H	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
H	↓	X	a	b	c	d	a	b	c	d
H	↓	X	Q_B†	Q_C†	Q_D†	d	Q_{Bn}	Q_{Cn}	Q_{Dn}	d
L	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
L	↓	H	X	X	X	X	H	Q_{An}	Q_{Bn}	Q_{Cn}
L	↓	L	X	X	X	X	L	Q_{An}	Q_{Bn}	Q_{Cn}

When the output control is low, the outputs are disabled to the high-impedance state; however, sequential operation of the registers is not affected.

†Shifting left requires external connection of Q_B to A, Q_C to B, and Q_D to C. Serial data is entered at input D.

H = high level (steady state), L = low level (steady state), X = irrelevant (any input, including transitions)
= transition from high to low level.
a, b, c, d = the level of steady-state input at inputs A, B, C, or D, respectively.
Q_{A0}, Q_{B0}, Q_{C0}, Q_{D0} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the indicated steady-state input conditions were established.
Q_{An}, Q_{Bn}, Q_{Cn}, Q_{Dn} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the most-recent transition of the clock.

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Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			−1			−2.6	mA
Low-level output current, I_{OL}			4			8	mA
Clock frequency, f_{clock}	0		30	0		30	MHz
Width of clock pulse, $t_{w(clock)}$	20			20			ns
Setup time, high-level or low-level data, t_{setup}	10			10			ns
Hold time, high-level or low-level data, t_{hold}	10			10			ns
Operating free-air temperature, T_A	−55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=−18mA				−1.5			−1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL} max, I_{OH}=MAX		2.4	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL} max	I_{OL}=4mA		0.25	0.4		0.25	0.40	V
		I_{OL}=8mA						0.35	
I_{OZH}	V_{CC}=MAX, V_{IL}=V_{IL} max, V_O=2.7V				20			20	μA
I_{OZL}	V_{CC}=MAX, V_{IH}=2V, V_O=0.4V				−20			−20	μA
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				−0.4			−0.4	mA
I_{OS}†	V_{CC}=MAX		−15		−100	−15		−100	mA
I_{CC}††	V_{CC}=MAX	Condition A		14	23		14	23	mA
		Condition B		15	25		15	25	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

††I_{CC} is measured with the outputs open, the serial input and mode control at 4.5V, and the data inputs grounded under the following conditions:

A. Output control at 4.5V and a momentary 3V, then ground, applied to clock input.

B. Output control and clock input grounded.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	−55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. C on page 2-147)										
f_{max}				30	40					MHz
t_{PLH}					27	35				ns
t_{PHL}					35	45				ns
t_{ZH}					10	18				ns
t_{ZL}					10	18				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. C on page 2-147)										
t_{HZ}					19	28				ns
t_{LZ}					24	32				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. C on page 2-147)										
f_{max}										MHz
t_{PLH}										ns
t_{PHL}										ns
t_{ZH}										ns
t_{ZL}										ns

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Quadruple 2-Input Multiplexers with Storage

LS298

FEATURES

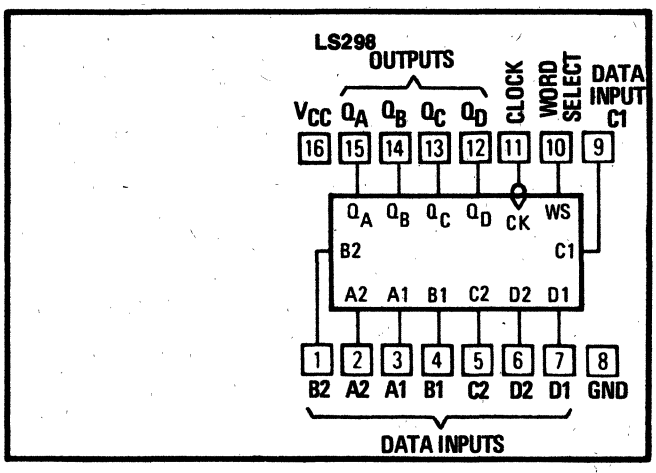
- **Selects One of Two 4-Bit Data Sources and Stores Data Synchronously with System Clock.**
- **Applications:**
  Dual Source for Operands and Constants in Arithmetic Processor; Can Release Processor Register Files for Acquiring New Data.
  Implement Separate Registers Capable of Parallel Exchange of Contents Yet Retain External Load Capability.
  Universal Type Register for Implementing Various Shift Patterns; Even Has Compound Left-Right Capabilities.

DESCRIPTION

These monolithic quadruple two-input multiplexers with storage provide essentially the equivalent functional capabilities of two separate MSI functions (54157/74157 or 54LS157/74LS157 and 54175/74175 or 54LS175/74LS175) in a single 16-pin package.

When the word-select input is low, word 1 (A1, B1, C1, D1) is applied to the flip-flops. A high input to word select will cause the selection of word 2 (A2, B2, C2, D2). The selected word is clocked to the output terminals on the negative-going edge of the clock pulse.

PIN-OUT DIAGRAM

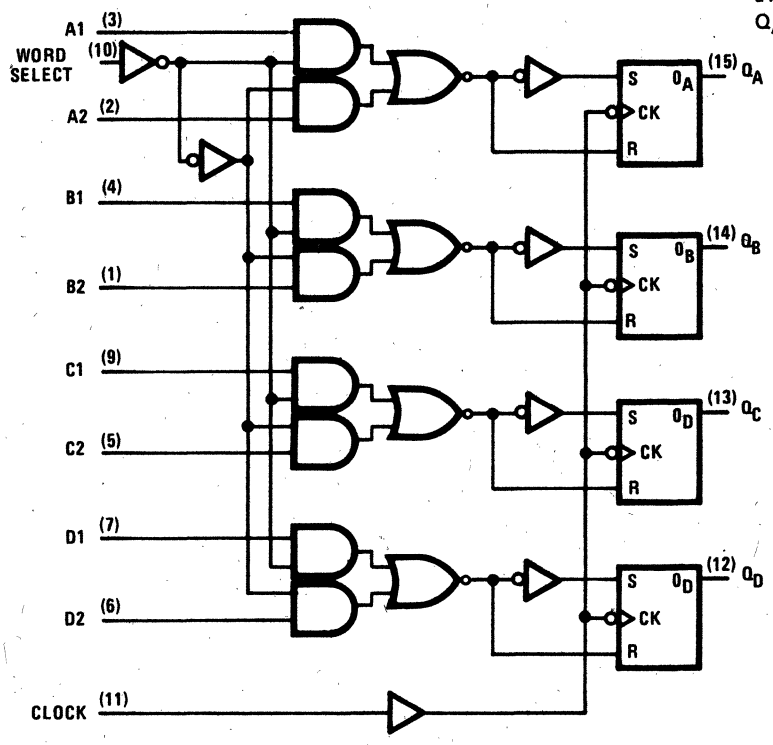


FUNCTION TABLE

INPUTS		OUTPUTS			
WORD SELECT	CLOCK	Q_A	Q_B	Q_C	Q_D
L	↓	a1	b1	c1	d1
H	↓	a2	b2	c2	d2
X	H	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}

H = high level (steady state)
L = low level (steady state)
X = irrelevant (any input, including transitions)
↓ = transition from high to low level
a1, a2, etc. = the level of steady-state input at A1, A2, etc.
Q_{A0}, Q_{B0} etc. = the level of Q_A, Q_B, etc. entered on the most recent ↓ transition of the clock input.

LOGIC DIAGRAM



. . . Dynamic input activated by a transition from a high level to a low level

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Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}				-400			-400	μA
Low-level output current, I_{OL}				4			8	mA
Width of clock pulse, high or low level, t_w		20			20			ns
Setup time, t_{setup}	Data	15			15			ns
	Word select	25			25			
Hold time, t_{hold}	Data	5			5			ns
	Word select	0			0			
Operating free-air temperature, T_A		-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-400μA		2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.4			-0.4	mA
I_{OS}†	V_{CC}=MAX		-6		-40	-5		-42	mA
I_{CC}††	V_{CC}=MAX,			13	21		13	21	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
††With all outputs open and all inputs except clock low, I_{CC} is measured after applying a momentary 4.5V, followed by ground, to the clock input.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter ¶	-55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ										
t_{PLH}					18	27				ns
t_{PHL}					21	32				
Test Conditions: C_L = 50pF, R_L = 2kΩ										
t_{PLH}										ns
t_{PHL}										

¶ t_{PLH} = propagation delay time, low-to-high level output
t_{PHL} = propagation delay time, high-to-low level output.

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LS365 LS366
LS367 LS368

DESCRIPTION

The LS365/366/367/368 are high speed hex buffers with 3-state outputs. They are organized as single 6-bit or 2-bit/4-bit, with inverting or non-inverting data (D) paths. The outputs are designed to drive 15TTL Unit Loads on 60 Low Power Schottky loads when the Enable ($\bar{E}$) is LOW.

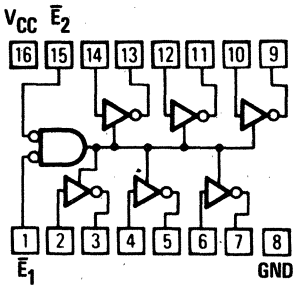
When Output Enable Input ($\bar{E}$) is HIGH, the outputs are forced to a high impedance "off" state. If the outputs of the 3-state devices are tied together, all but one device must be in the high impedance state to avoid high currents that would exceed the maximum ratings. Designers should ensure that Output Enable signals to 3-state devices whose outputs are tied together are designed so there is no overlap.

PIN-OUT DIAGRAMS

LS365
HEX 3-STATE BUFFER WITH COMMON 2-INPUT NOR ENABLE

TRUTH TABLE

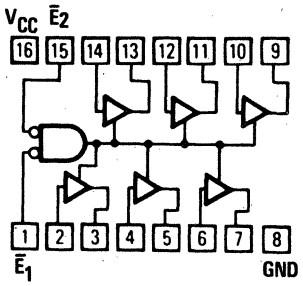
INPUTS			OUTPUTS
$\bar{E}_1$	$\bar{E}_2$	D	
L	L	L	L
L	L	H	H
H	X	X	(Z)
X	H	X	(Z)



LS366
HEX 3-STATE INVERTER BUFFER WITH COMMON 2-INPUT NOR ENABLE

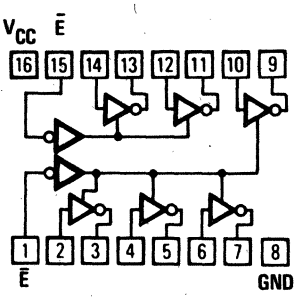
TRUTH TABLE

INPUTS			OUTPUTS
$\bar{E}_1$	$\bar{E}_2$	D	
L	L	L	H
L	L	H	L
H	X	X	(Z)
X	H	X	(Z)



LS367
HEX 3-STATE BUFFER SEPARATE 2-BIT AND 4-BIT SECTIONS

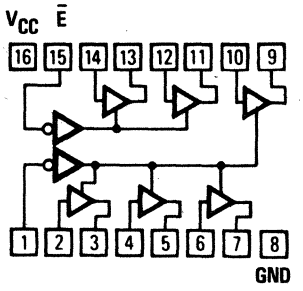
INPUTS		OUTPUTS
$\bar{E}$	D	
L	L	L
L	H	H
H	X	(Z)



LS368
HEX 3-STATE INVERTER BUFFER SEPARATE 2-BIT AND 4-BIT SECTIONS

TRUTH TABLE

INPUTS		OUTPUTS
$\bar{E}$	D	
L	L	H
L	H	L
H	X	(Z)



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Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply Voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-Level Output Current, I_{OH}			-1			-2.6	mA
Low-Level Output Current, I_{OL}			12			24	mA
Operating Free-Air Temperature, T_A	-55		125	0		75	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}	Guaranteed Input HIGH Voltage for All Inputs		2.0			2.0			V
V_{IL}	Guaranteed Input LOW Voltage for All Inputs				.7	2.0		.8	V
V_{CD}	V_{CC}=MIN, I_{IN}=-18mA			-0.65	-1.5		-0.65	-1.5	V
V_{OH}	V_{CC}=MIN, V_{IN}=V_{IH} or V_{IL} per Truth Table	I_{OH}=-1.0mA	2.4	3.4					V
		I_{OH}=-2.6mA				2.4	3.1		
V_{OL}	V_{CC}=MIN, V_{IN}=V_{IH} or V_{IL} per Truth Table	I_{OL}=12mA		0.25	0.4		0.25	0.40	V
		I_{OL}=24mA					0.35	0.5	
I_{OZH}	V_{CC}=MAX, V_{out}=2.4V, $V_{\overline{E}}$=2.0V				20			20	µA
I_{OZL}	V_{CC}=MAX, V_{out}=0.4V, $V_{\overline{E}}$=2.0V				-20			-20	µA
I_{IH}	V_{CC}=MAX, V_{IN}=2.7V				20			20	µA
	V_{CC}=MAX, V_{IN}=7.0V				-.1			-.1	mA
I_{IL}	V_{CC}=MAX, V_{IN}=0.4V				-0.4			-0.4	mA
I_{OS}†	V_{CC}=MAX, V_{OUT}=0V		-30		-100	-30		-100	mA
I_{CC}	V_{CC}=MAX, V_{IN}=0V, $V_{\overline{E}}$=4.5V	LS365/367		13.5	24		13.5	24	mA
		LS366/368		11.8	21		11.8	21	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	-55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 45 pF										
t_{PLH} (LS365/367)						10				ns
t_{PHL} (LS365/367)						16				
t_{PLH} (LS366/368)						10				ns
t_{PHL} (LS366/368)						16				
Test Conditions: C_L = 45 pF, R_L = 667Ω										
t_{ZH}						16				ns
t_{ZL}						30				
Test Conditions: C_L = 5 pF, R_L = 667Ω										
t_{LZ}						15				ns
t_{HZ}						23				
Test Conditions: C_L = 125 pF										
t_{PLH} (LS365/367)										ns
t_{PHL} (LS365/367)										
t_{PLH} (LS366/368)										ns
t_{PHL} (LS366/368)										
t_{ZH}										ns
t_{ZL}										

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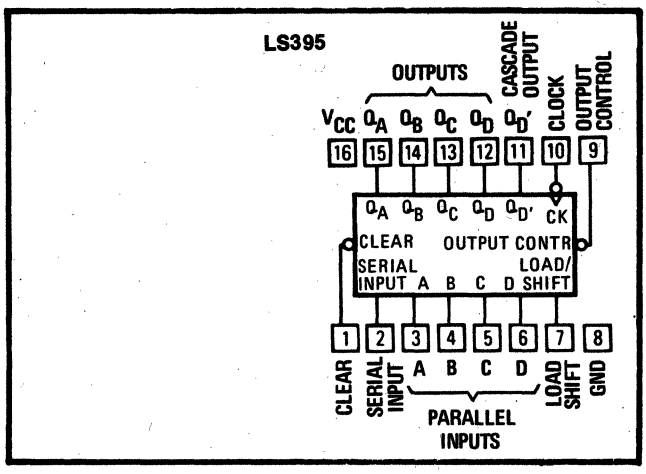
4-Bit Cascadable Shift Registers with 3-State Outputs

LS39

FEATURES

- Three-State, 4-Bit, Cascadable, Parallel-In, Parallel-Out Registers
- Schottky-Diode-Clamped Transistors
- Low Power Dissipation . . . 75mW Typical (Enabled)
- Applications:
  - N-Bit Serial-To-Parallel Converter
  - N-Bit Parallel-To-Serial Converter
  - N-Bit Storage Register

PIN-OUT DIAGRAM



DESCRIPTION

These 4-bit registers feature parallel inputs, parallel outputs, and clock, serial, load/shift, output control and direct overriding clear inputs.

Shifting is accomplished when the load/shift control is low. Parallel loading is accomplished by applying the four bits of data and taking the load/shift control input high. The data is loaded into the associated flip-flops and appears at the outputs after the high-to-low transition of the clock input. During parallel loading, the entry of serial data is inhibited.

When the output control is low, the normal logic levels of the four outputs are available for driving the loads or bus lines. The outputs are disabled independently from the level of the clock by a high logic level at the output control input. The outputs then present a high impedance and neither load nor drive the bus line; however, sequential operation of the reigsters is not affected. During the high-impedance mode, the output at $Q_{D'}$ is still available for cascading.

The 9LS/54LS395 is characterized for operation over the full military temperature range of −55°C to 125°C; the 9LS/74LS395 is characterized for operation from 0°C to 70°C.

FUNCTION TABLE

INPUTS								3-STATE OUTPUTS				CASCADE
CLEAR	LOAD/SHIFT CONTROL	CLOCK	SERIAL	PARALLEL A	B	C	D	Q_A	Q_B	Q_C	Q_D	OUTPUT Q_D
L	X	X	X	X	X	X	X	L	L	L	L	L
H	H	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}	Q_{D0}
H	H	↓	X	a	b	c	d	a	b	c	d	d
H	L	H	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}	Q_{D0}
H	L	↓	H	X	X	X	X	H	Q_{An}	Q_{Bn}	Q_{Cn}	Q_{Cn}
H	L	↓	L	X	X	X	X	L	Q_{An}	Q_{Bn}	Q_{Cn}	Q_{Cn}

When the output control is high, the 3-state outputs are disabled to the high-impedance state; however, sequential operation of the registers and the output at Q_D are not affected.

H = high level (steady state), L = low level (steady state), X = irrelevant (any input, including transitions)

↓ = transition from high to low level.

Q_{A0}, Q_{B0}, Q_{C0}, Q_{D0} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the indicated steady state input conditions were established.

Q_{An}, Q_{Bn}, Q_{Cn}, Q_{Dn} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the most recent ↓ transition of the clock.

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Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-1			-2.6	mA
Low-level output current, I_{OL}			4			8	mA
Clock frequency, f_{clock}	0		25	0		25	MHz
Width of clock pulse, $t_{w(clock)}$	25			25			ns
Setup time, high-level or low-level data, t_{setup}	20			20			ns
Hold time, high-level or low-level data, t_{hold}	10			10			ns
Operating free-air temperature, T_A	-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=MAX		2.4	3.4		2.4	3.1		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.4		0.25	0.4	V
		I_{OL}=8mA					0.35	0.5	
I_{OZH}	V_{CC}=MAX, V_{IH}=2V, V_O=2.7V				20			20	μA
I_{OZL}	V_{CC}=MAX, V_{IH}=2V, V_O=0.4V				-20			-20	μA
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.4			-0.4	mA
I_{OS}†	V_{CC}=MAX		-6		-40	-5		-42	mA
I_{CC}††	V_{CC}=MAX,	Condition A		18	29		18	29	mA
		Condition B		15	25		15	25	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

††I_{CC} is measured with the outputs open, the serial input and mode control at 4.5V, and the data inputs grounded under the following conditions:

A. Output control at 4.5V and a momentary 3V, then ground, applied to clock input.

B. Output control and clock input grounded.

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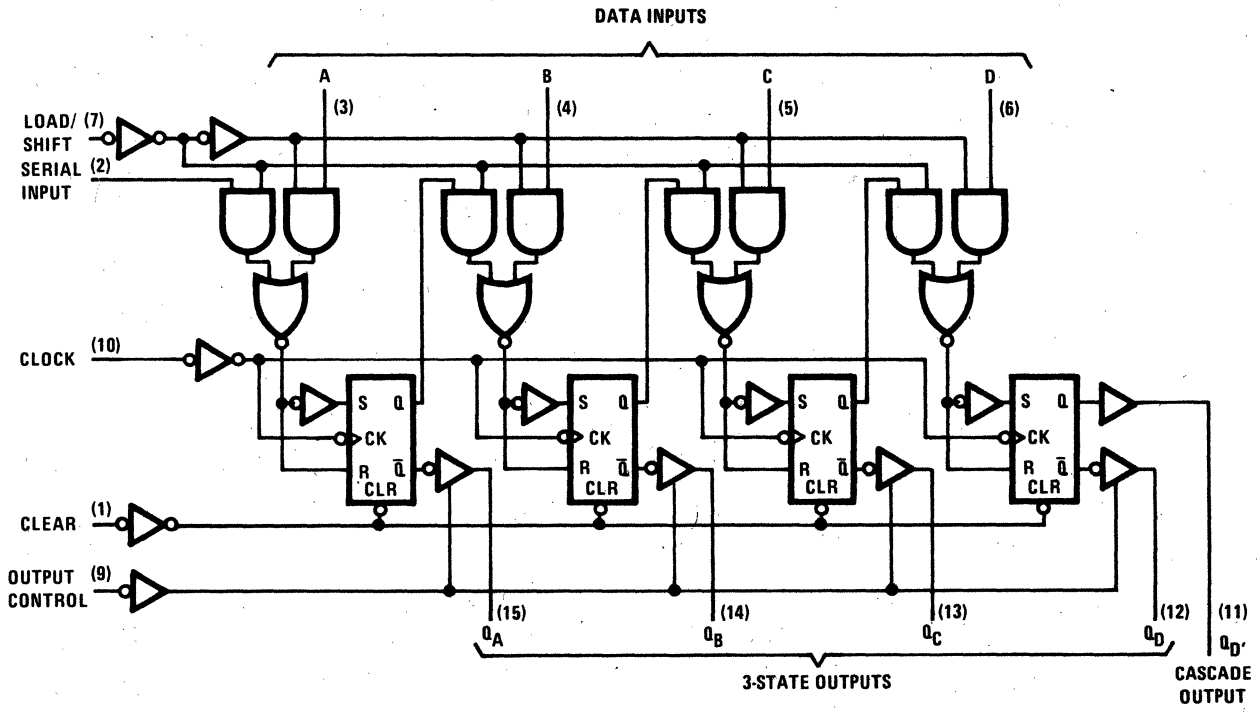
4-Bit Cascadable Shift Registers with 3-State Outputs

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	−55°C			+25°C			+125°C			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ										
f_{max}				25	35					MHz
t_{PLH}					18	27				ns
t_{PHL}					21	32				ns
t_{ZH}					15	25				ns
t_{ZL}					20	30				ns
Test Conditions: C_L = 5.0 pF, R_L = 2kΩ										
t_{HZ}					30	50				ns
t_{LZ}					30	50				ns
Test Conditions: C_L = 50pF, R_L = 2kΩ										
f_{max}										MHz
t_{PLH}										ns
t_{PHL}										ns
t_{ZH}										ns
t_{ZL}										ns

LOGIC DIAGRAM



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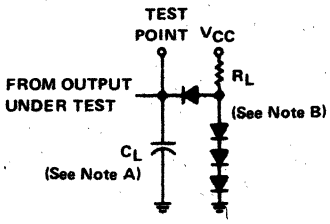
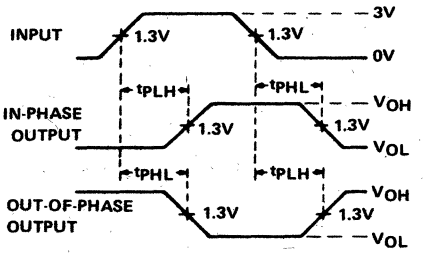
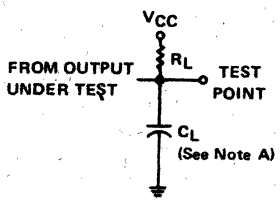


LOAD CIRCUIT

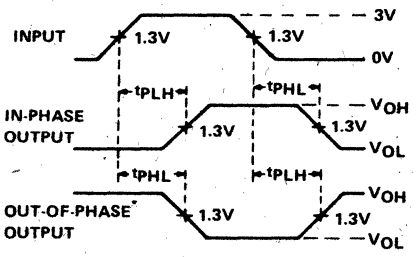


VOLTAGE WAVEFORMS

FIGURE A — FOR TOTEM-POLE OUTPUTS

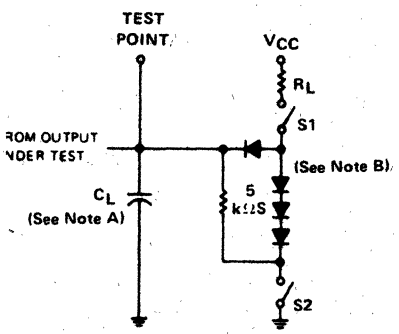


LOAD CIRCUIT

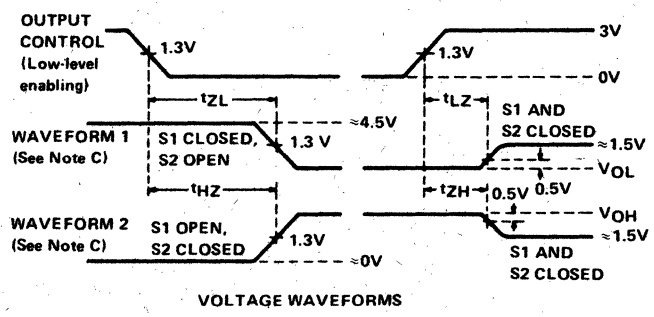


VOLTAGE WAVEFORMS

FIGURE B — FOR OPEN-COLLECTOR OUTPUTS



LOAD CIRCUIT



VOLTAGE WAVEFORMS

FIGURE C — FOR THREE-STATE OUTPUTS

NOTES:
A. C_L includes probe and jig capacitance.
B. All diodes are 1N3064.
C. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
D. In the examples above, the phase relationships between inputs and outputs have been chosen arbitrarily.
E. All input pulses are supplied by generators having the following characteristics: $t_r \leq 15$ ns, $t_f \leq 6$ ns, PRR ≤ 1 MHz, $Z_{out} \approx 50\ \Omega$, and $t_w = 100$ ns.

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25LS

Advanced Low-Power Schottky Technology

The need for high-performance, low-power Schottky devices evolved from the use of high-speed microprocessors in military and telecommunications systems. Raytheon has met this need with the 25LS family.

Raytheon has fully specified the 25LS devices to meet the requirements of high-speed operations over a wide range of environmental conditions. Check the following specifications and see for yourself. Raytheon is the leader in low-power Schottky.

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RAYTHEON

SEMICONDUCTOR DIVISION

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25LS138
Switching Characteristics, V_{CC} = 5V, T_A = +25°C

Parameter	Levels of Delay	From (input)	To (output)	+25°C Min	+25°C Typ	+25°C Max	Unit
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A, page 2-147)							
t_{PLH}	2	Binary Select	Any		10	15	ns
t_{PLH}					14	20	ns
t_{PLH}	3				15	23	ns
t_{PLH}					18	27	ns
t_{PLH}	2	Enable	Any		10	15	ns
t_{PLH}					15	23	ns
t_{PLH}	3				12	18	ns
t_{PLH}					18	27	ns

25LS139
Switching Characteristics, V_{CC} = 5V, T_A = +25°C

Parameters	Levels of Delay	From (input)	To (output)	+25°C Min	+25°C Typ	+25°C Max	Unit
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A, page 2-147)							
t_{PLH}	2	Binary Select	Any		10	15	ns
t_{PLH}					12	18	ns
t_{PLH}	3				13	20	ns
t_{PLH}					14	21	ns
t_{PLH}	2	Enable	Any		9	12	ns
t_{PLH}					11	16	ns

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8-Line-To-1-Line Multiplexers

25LS151

FEATURES

- Select one of eight data sources
- Perform parallel-to-serial conversion
- 25LS151 has complementary outputs
- 25LS151 has strobe input
- Higher Speed compared to 9LS/54LS and 9LS/74LS
- 8mA sink current over full military temperature range
- 50mV improved V_{OL} compared to 9LS/74LS
- 440μA source current
- 100% reliability assurance testing in compliance with MIL-STD-883

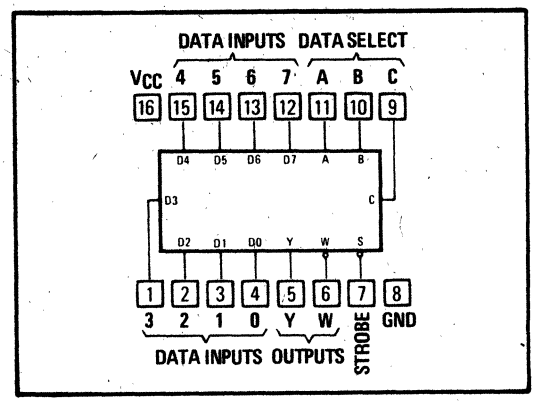
DESCRIPTION

These monolithic data selectors/multiplexers contain full on-chip binary decoding to select one-of-eight data sources. The 25LS151 has a strobe input which must be at a low logic level to enable the device. A high level at the strobe forces the W output high, and the Y output low.

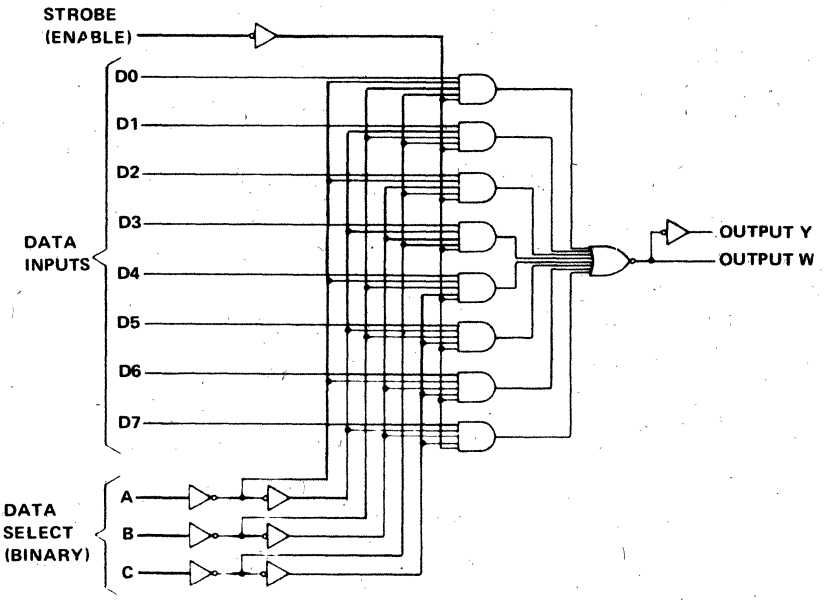
The 25LS151 features complementary W and Y outputs.

PIN-OUT DIAGRAMS

25LS151



LOGIC DIAGRAMS



25LS151 FUNCTION TABLE

INPUTS				OUTPUTS	
SELECT			STROBE		
C	B	A	S	Y	W
X	X	X	H	L	H
L	L	L	L	D0	$\overline{D0}$
L	L	H	L	D1	$\overline{D1}$
L	H	L	L	D2	$\overline{D2}$
L	H	H	L	D3	$\overline{D3}$
H	L	L	L	D4	$\overline{D4}$
H	L	H	L	D5	$\overline{D5}$
H	H	L	L	D6	$\overline{D6}$
H	H	H	L	D7	$\overline{D7}$

H = high level, L = low level, X = don't care
D0, D1 . . . D7 = the level of the D respective input

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Recommended Operating Conditions

	Military			Commercial			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			–440			–440	μA
Low-level output current, I_{OL}			8			8	mA
Operating free-air temperature, T_A	–55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		Military			Commercial			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=–18mA				–1.5			–1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max I_{OH}= –440μA		2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.40			0.40	V
		I_{OL}=8mA		0.3	0.45		0.35	0.45	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				–0.4			–0.4	mA
I_{OS}†	V_{CC}=MAX		–15		–100	–15		–100	mA
I_{CC}	V_{CC}=MAX, Outputs open, All inputs at 4.5V			6.0	10		6.0	10	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

Switching Characteristics, V_{CC} = 5V, T_A = +25°C

Parameter	From (input)	To (output)	+25°C			Unit
			Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A, page 2-147)						
t_{PLH}	A, B or C (4 levels)	Y		272	41	ns
t_{PLH}				20	30	
t_{PLH}	A, B, or C (3 levels)	W		16	23	ns
t_{PLH}				22	32	
t_{PLH}	Strobe	Y		22	33	ns
t_{PLH}				18	27	
t_{PLH}	Strobe	W		13	20	ns
t_{PLH}				17	26	
t_{PLH}	Any D	Y		17	26	ns
t_{PLH}				15	23	
t_{PLH}	Any D	W		10	15	ns
t_{PLH}				10	15	

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8-Line-To-1-Line Multiplexer With Three-State Outputs

25LS251

FEATURES

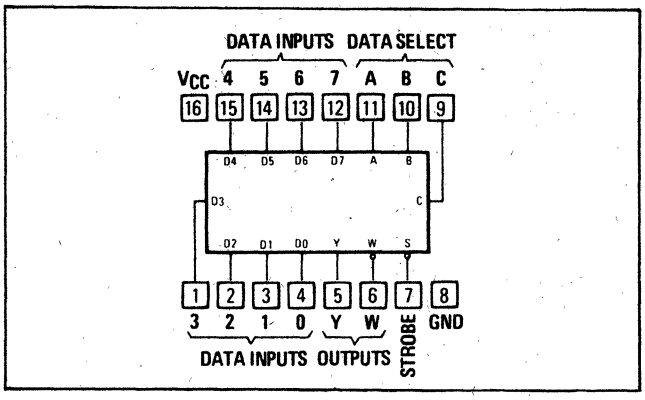
- **Selects one of eight data sources**
- **Performs parallel-to-serial conversion**
- **Complementary 3-state outputs**
- **Higher speed compared to 9LS/54LS and 9LS/74LS**
- **8mA sink current over full military temperature range**
- **50mV improved V_{OL} compared to 9LS/74LS**
- **440μA source current**
- **100% reliability assurance testing in compliance with MIL-STD-883.**

DESCRIPTION

This monolithic data selector/multiplexer contains full on-chip binary decoding to select one-of-eight data sources and features a strobe-controlled three-state output. The strobe must be at a low logic level to enable this device. The three-state outputs permit a number of outputs to be connected to a common bus. When the strobe input is high, both outputs are in a high-impedance state in which both the upper and lower transistors of each totem-pole output are off, and the output neither drives nor loads the bus significantly. When the strobe is low, the outputs are activated and operate as standard TTL totem-pole outputs.

To minimize the possibility that two outputs will attempt to take a common bus to opposite logic levels, the output control circuitry is designed so that the average output disable time is shorter than the average output enable time.

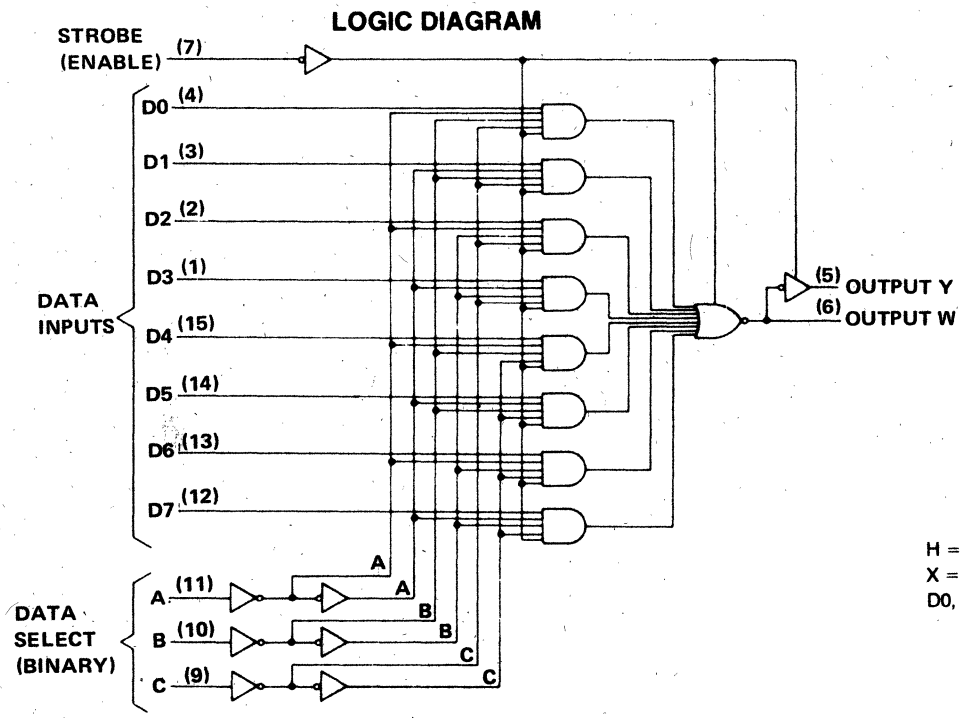
PIN-OUT DIAGRAM



Recommended Operating Conditions

	9LS/54LS			9LS/74LS			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-1			-2.6	mA
Low-level output current, I_{OL}			8			8	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

LOGIC DIAGRAM



FUNCTION TABLE

INPUTS				OUTPUTS	
SELECT			STROBE		
C	B	A	S	Y	W
X	X	X	H	Z	Z
L	L	L	L	D0	$\overline{D0}$
L	L	H	L	D1	$\overline{D1}$
L	H	L	L	D2	$\overline{D2}$
L	H	H	L	D3	$\overline{D3}$
H	L	L	L	D4	$\overline{D4}$
H	L	H	L	D5	$\overline{D5}$
H	H	L	L	D6	$\overline{D6}$
H	H	H	L	D7	$\overline{D7}$

H = high logic level, L = low logic level
X = irrelevant, Z = high impedance (off)
D0, D1 . . . D7 = the level of the respective D input

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Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		9LS/54LS			9LS/74LS			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=MAX, I_{OH}=MAX		2.4	3.4		2.4	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=MAX,	I_{OL}=4mA		0.25	0.40		0.25	0.40	V
		I_{OL}=8mA		0.30	0.45		0.30	0.45	
$I_{O(off)}$	V_{CC}=MAX, V_{IH}=2V	V_O=2.7V			20			20	μA
		V_O=0.4V			-20			-20	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.4			-0.4	mA
I_{OS}†	V_{CC}=MAX		-15		-85	-15		-85	mA
I_{CC}††	V_{CC}=MAX	Condition A		6.1	10		6.1	10	mA
		Condition B		7.1	12		7.1	12	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

††I_{CC} is measured with the outputs open and all data and select inputs at 4.5V under the following conditions:

A. Strobe grounded.

B. Strobe at 4.5V

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8-Line-To-1-Line Multiplexer With Three-State Outputs

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter ¶	From (input)	To (output)	−55°C			+25°C			+125°C			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. C on page 2-147)												
t_{PLH}	A, B, or C (4 levels)	Y					29	44				ns
t_{PHL}							20	30				
t_{PLH}	A, B, or C (3 levels)	W					16	24				ns
t_{PHL}							21	32				
t_{PLH}	Any D	Y					14	24				ns
t_{PHL}							11	17				
t_{PLH}	Any D	W					8	12				ns
t_{PHL}							9	14				
t_{ZH}	Strobe	Y					9	12				ns
t_{ZL}							13	19				
t_{ZH}	Strobe	W					4	15				ns
t_{ZL}							13	18				
Test Conditions: C_L = 5pF, R_L = 2kΩ (See Fig. C on page 2-147)												
t_{HZ}	Strobe	Y					9	27				ns
t_{LZ}							10	18				
t_{HZ}	Strobe	W					17	29				ns
t_{LZ}							10	18				

¶ t_{PLH} = propagation delay time, low-to-high-level output.
t_{PHL} = propagation delay time, high-to-low-level output.
t_{ZH} = output enable time to high level.
t_{ZL} = output enable time to low level.
t_{HZ} = output disable time from high level.
t_{LZ} = output disable time from low level.

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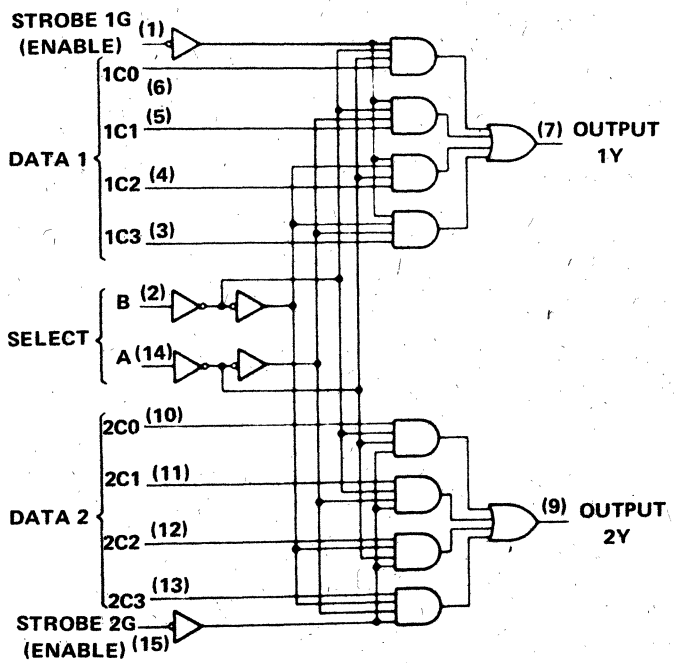
FEATURES

- Permits multiplexing from N lines to 1 line
- Performs parallel-to-serial conversion
- Strobe (Enable) line provided for cascading (N lines to n lines)
- Non-inverting
- Higher Speed compared to 9LS/54LS and 9LS/74LS
- 8mA sink current over full military temperature range
- 50mV improved V_{OL} compared to 9LS/74LS
- 440μA source current
- 100% reliability assurance testing in compliance with MIL-STD-883

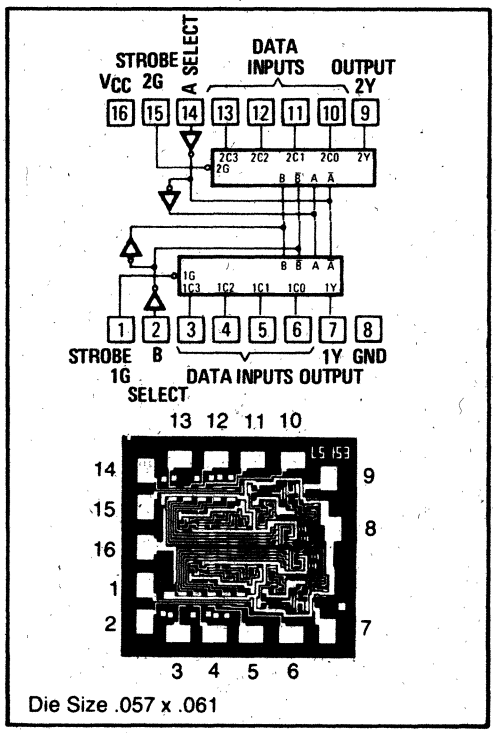
DESCRIPTION

The 25LS153 is a high speed Dual 4-Line to 1-Line Multiplexer with common select inputs and separate strobe (enable) inputs for each half. Each half can select one bit of four and present it at the output in non-inverted form.

LOGIC DIAGRAM



PIN-OUT DIAGRAM



FUNCTION TABLE

SELECT INPUTS		DATA INPUTS				STROBE	OUTPUT
B	A	C0	C1	C2	C3	G	Y
X	X	X	X	X	X	H	L
L	L	L	X	X	X	L	L
L	L	H	X	X	X	L	H
L	H	X	L	X	X	L	L
L	H	X	H	X	X	L	H
H	L	X	X	L	X	L	L
H	L	X	X	H	X	L	H
H	H	X	X	X	L	L	L
H	H	X	X	X	H	L	H

Select inputs A and B are common to both sections.

H = high level, L = low level, X = don't care

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Dual 4-Line-To-1-Line Multiplexer 25LS153

Recommended Operating Conditions

	Military			Commercial			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.5	V
High-level output current, I_{OH}			–440			-400	μA
Low-level output current, I_{OL}			8			8	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		Military			Commercial			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=–440μA		2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.40			0.40	V
		I_{OL}=8mA		0.3	0.45		0.35	0.45	
I_I	V_{CC}=MAX, V_I=7.0V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.36			-0.36	mA
I_{OS}†	V_{CC}=MAX		-15		–85	-15		–85	mA
I_{CCL}††	V_{CC}=MAX			6.2	10		6.2	10	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
†† I_{CCL} is measured with the outputs open and all inputs grounded.

Switching Characteristics, V_{CC} = 5V, T_A = +25°C

Parameter	From (input)	To (output)	+25°C			Unit
			Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A, page 2-147)						
t_{PLH}	Data	Y		7	13	ns
t_{PLH}	Data	Y		10	16	ns
t_{PLH}	Select	Y		16	24	ns
t_{PLH}	Select	Y		20	25	ns
t_{PLH}	Strobe	Y		13	n-,20	ns
t_{PLH}	Strobe	Y		15	20	ns

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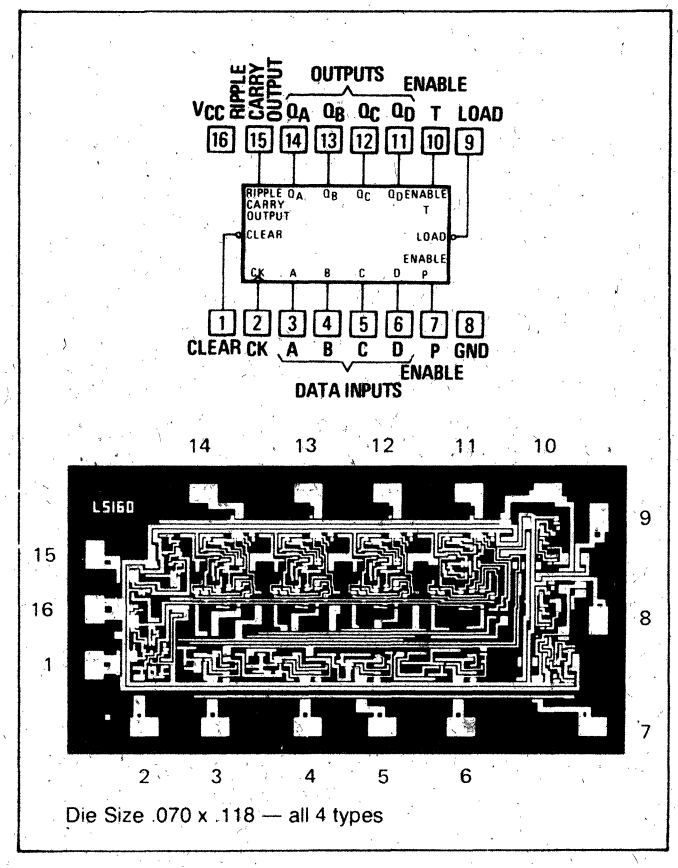
25LS160 25LS162 Synchronous BCD Decade Counters

25LS161 25LS163 Synchronous 4-Bit Binary Counters

FEATURES

- 4-bit synchronous counters
- Synchronously programmable
- Internal look-ahead counting
- Carry output for n-bit cascading
- Synchronous or asynchronous clear
- Advanced low-power Schottky technology
- 100% reliability assurance testing in compliance with MIL-STD-883
- Higher speed compared to 9LS/54LS and 9LS/74LS
- 8mA sink current over full military temperature range
- 50mV improved V_{OL} compared to 9LS/74LS
- 440μA source current

PIN-OUT DIAGRAM



Die Size .070 x .118 — all 4 types

DESCRIPTION

The 25LS160, 25LS161, 25LS162 and 25LS163 synchronous, presettable counts have internal look-ahead carry and ripple carry output for high-speed counting applications. The 25LS160 and 25LS162 are decade counters and the 25LS161 and 25LS163 are 4-bit binary counters. Counting or loading occurs on the positive transition of the clock pulse. A LOW level on the load input causes the data on the A, B, C and D inputs to be shifted to the appropriate Q outputs on the next positive clock transition.

The 25LS160 and 25LS161 feature an asynchronous clear. A LOW level at the clear input sets the Q outputs LOW regardless of the other inputs. The 25LS162 and 25LS163 have a synchronous clear. A LOW level at the clear input sets the Q outputs LOW after the next positive clock transition regardless of the enable inputs.

Both count-enable inputs P and T must be HIGH to count. Count enable T is included in the ripple carry output gate for cascading connection.

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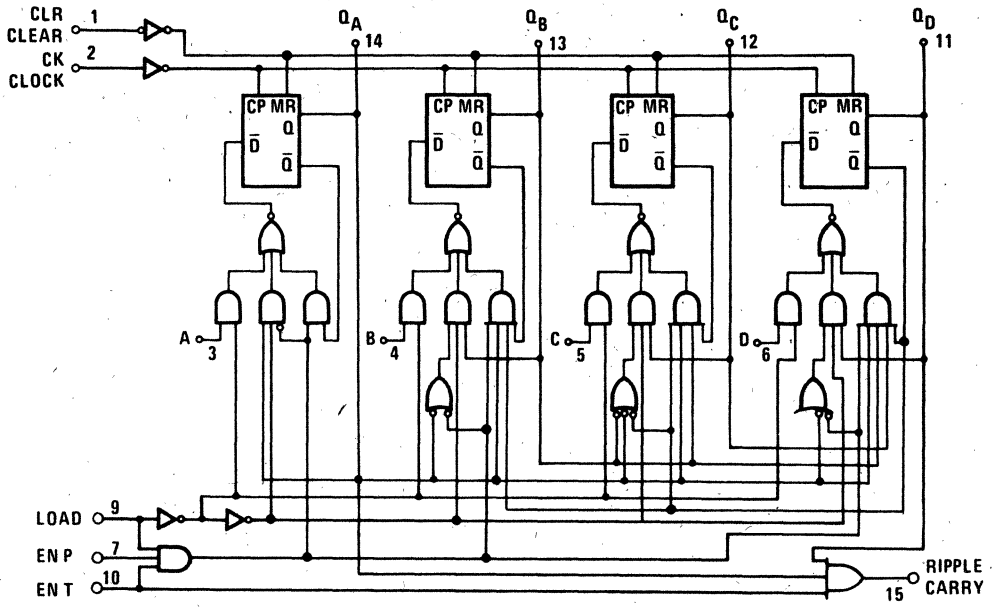
Synchronous BCD Decade Counters — 25LS160 25LS162
Synchronous 4-Bit Binary Counters — 25LS161 25LS163

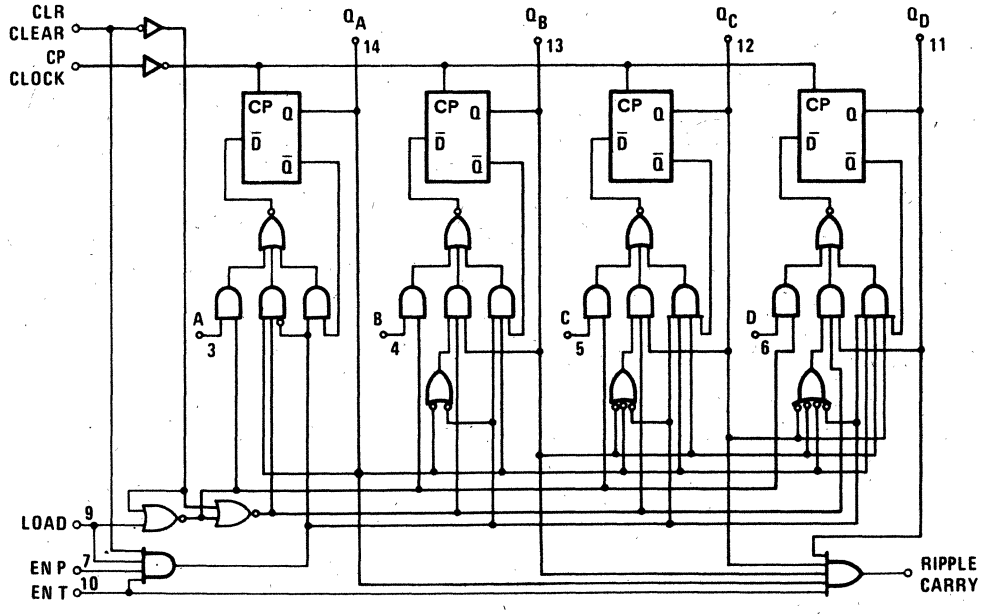
LOGIC DIAGRAMS

25LS160
Synchronous Decade Counter



25LS162 synchronous decade counters are similar; however, the clear is synchronous as shown for the 25LS163 binary counters.

25LS163 SYNCHRONOUS
BINARY COUNTER



25LS161 synchronous binary counters are similar; however, the clear is asynchronous as shown for the 25LS160 decade counters.

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Recommended Operating Conditions

	Military			Commercial			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			–440			-440	μA
Low-level output current, I_{OL}			8			8	mA
Operating free-air temperature, T_A	-5.5		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		Military			Commercial			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=–440μA		2.5	3.4		2.7	3.4		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max,	I_{OL}=4mA		0.25	0.40		0.25	0.40	V
			I_{OL}=8mA		0.35	0.45		0.35	0.5	
I_I	Data or enable P	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
	Load, clock, or enable T					0.2			0.2	
	Clear (LS160,161)					0.1			0.1	
	Clear (LS162,163)					0.2			0.2	
I_{IH}	Data or enable P	V_{CC}=MAX, V_I=2.7V				20			20	μA
	Load, clock, or enable T					40			40	
	Clear (LS160,161)					20			20	
	Clear (LS162,163)					40			40	
I_{IL}	Data or enable P	V_{CC}=MAX, V_I=0.4V				-0.4			-0.4	mA
	Load, clock, or enable T					-0.8			-0.8	
	Clear(LS160,161)					-0.4			-0.4	
	Clear(LS162,163)					-0.8			-0.8	
I_{OS}†		V_{CC}=MAX		-15		-85	-15		-85	mA
I_{CCH}		V_{CC}=MAX, See Note 1			18	31		18	31	mA
I_{CCL}		V_{CC}=MAX, See Note 2			19	32		19	32	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.

NOTES:
1. I_{CCH} is measured with the load input high, then again with the load input low, with all other inputs high and all outputs open.
2. I_{CCL} is measured with the clock input high, then again with the clock input low, with all other inputs low and all outputs open.

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Synchronous BCD Decade Counters — 25LS160 25LS162
Synchronous 4-Bit Binary Counters — 25LS161 25LS163

Switching Characteristics, V_{CC} = 5V, T_A = + 25°C

Parameter		+25°C Min	+25°C Typ	+25°C Max	Unit
Test Conditions: C_L = 5pF, R_L = 2kΩ					
t_{PLH}	Clock to Carry Output		25	35	ns
t_{PHL}	Clock to Carry Output		20	35	
t_{PLH}	Clock to Q Output with Load		10	18	ns
t_{PHL}	Input HIGH		15	20	
t_{PLH}	Enable T to Carry Output		15	20	ns
t_{PHL}			9	14	
t_{PLH}	Clock to Q Output with Load		10	18	ns
t_{PHL}	Input LOW		14	20	
t_{PHL}	(Note 1)		14	28	ns
t_{pw}	Clock	25			ns
	Clear	20			
t_s	Data - A,B,C,D	20			ns
	Enable P	20			
	Load, Enable T	20			
	Clear (Note 2)	20			
t_h		3			ns
f_{max}		30	40		MHz

NOTES:
1. Measured from clear input on 25LS160 and 25LS161. Measured from clock input on 25LS162 and 25LS163.
2. Applies to 25LS162 and 25LS163 only.

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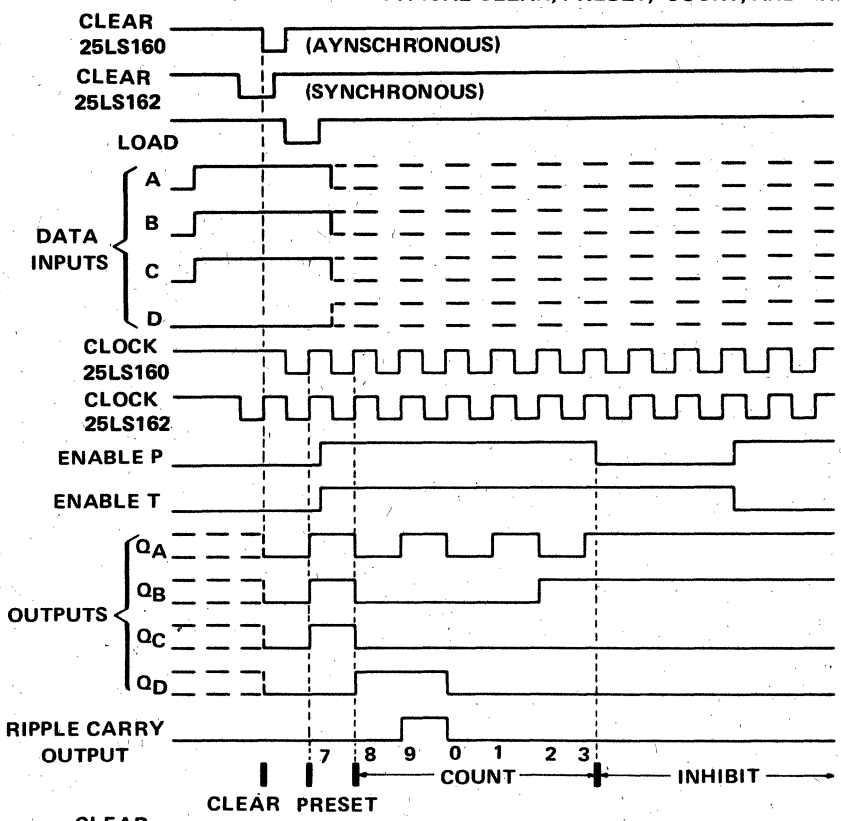
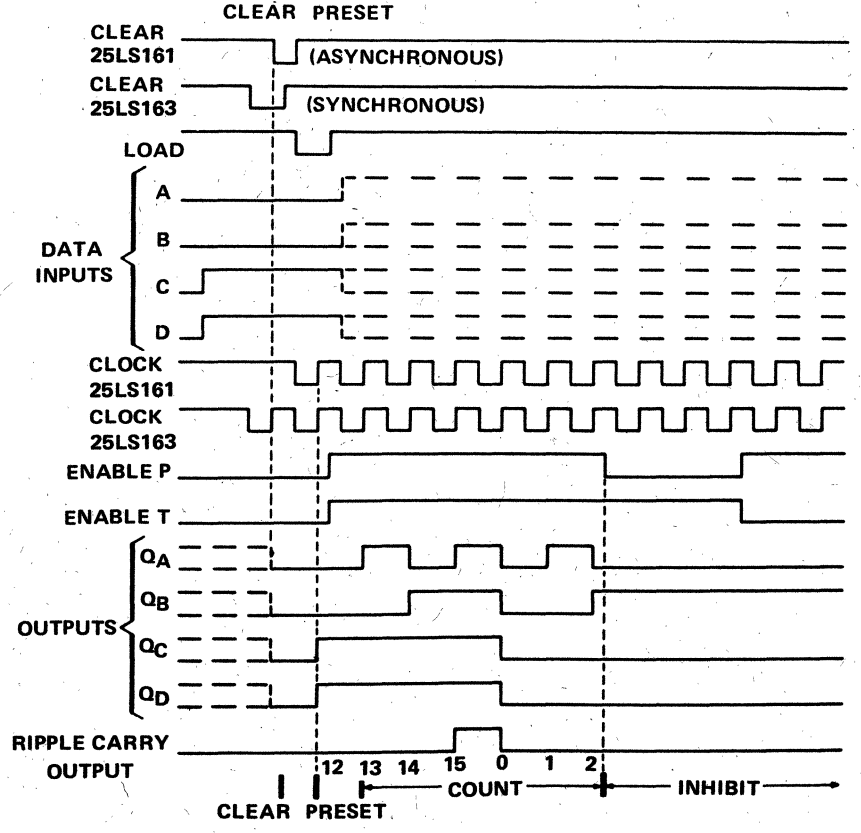
TYPICAL CLEAR, PRESET, COUNT, AND INHIBIT SEQUENCES



25LS160, 25LS162

Illustrated below is the following sequence:
1. Clear outputs to zero
2. Preset to BCD seven
3. Count to eight, nine, zero, one, two, and three
4. Inhibit



25LS161, 25LS163

Illustrated below is the following sequence:
1. Clear outputs to zero
2. Preset to binary twelve
3. Count to thirteen; fourteen fifteen, zero, one, and two
4. Inhibit

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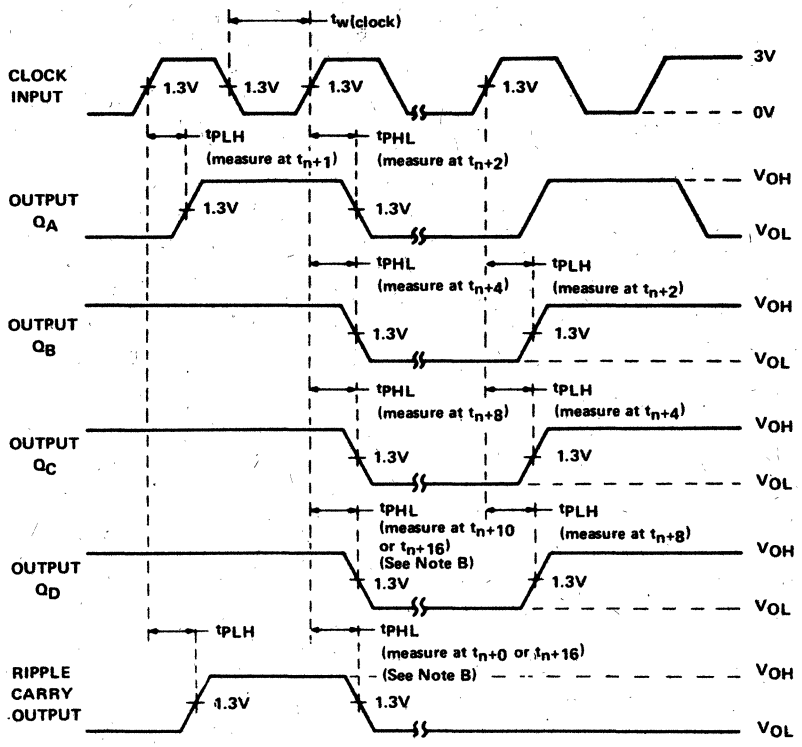
Synchronous BCD Decade Counters 25LS160 25LS162
Synchronous 4-Bit Binary Counters 25LS161 25LS163

FIGURE 1

PARAMETER MEASUREMENT INFORMATION



VOLTAGE WAVEFORMS

NOTES:

A. The input pulses are supplied by a generator having the following characteristics: PRR ≤ MHz, duty cycle ≤ 50%, $Z_{out} \approx 50\Omega$: $t_r \leq 15$ ns, $t_f \leq 6$ ns. Vary PRR to measure f_{max}.

B. Outputs Q_d and carry are tested at t_{n+10}25LS162, and at t_{n+16} for 25LS163 where t_n is the bit time when all outputs are low.

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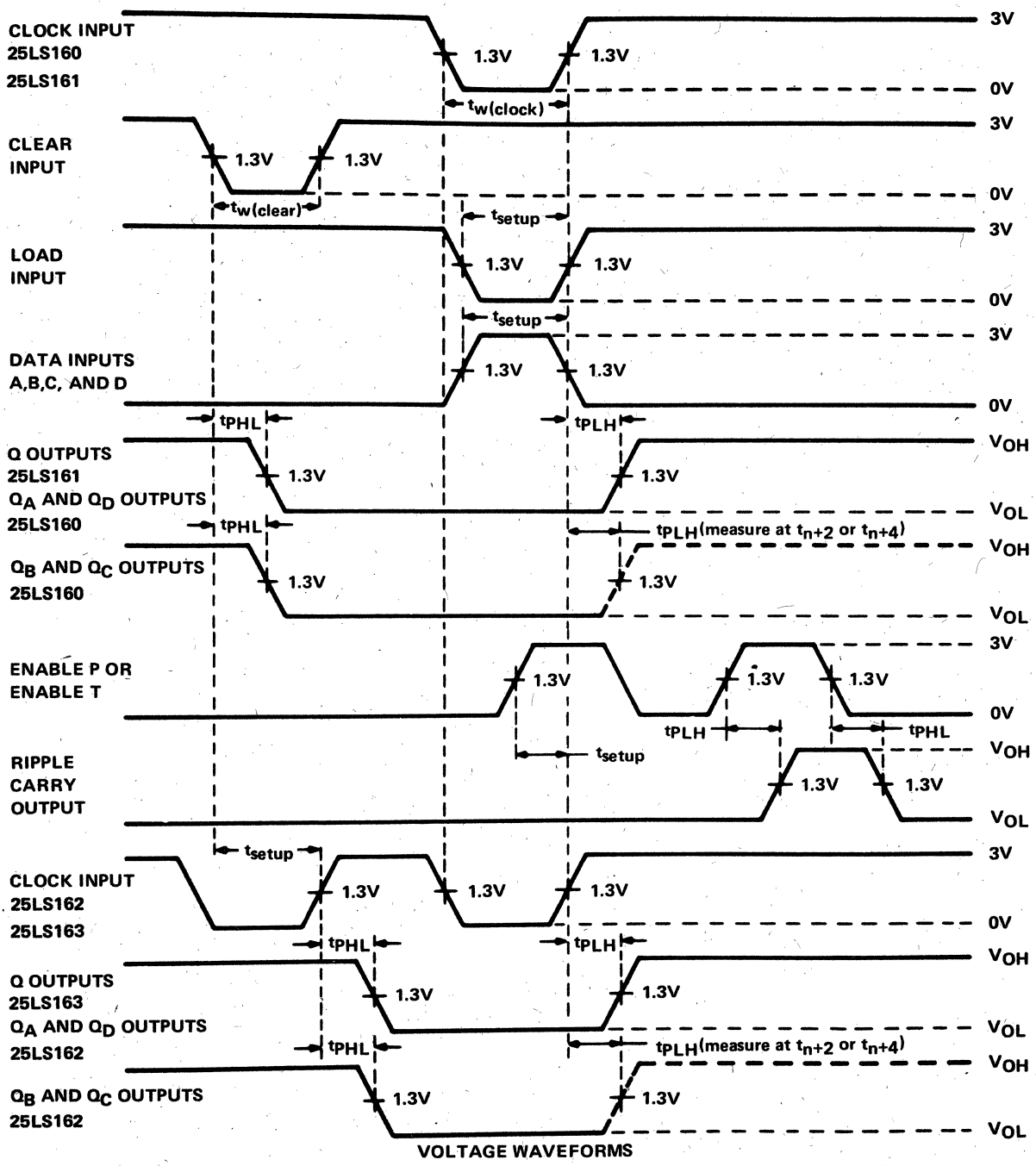
FIGURE 2

PARAMETER MEASUREMENT INFORMATION



VOLTAGE WAVEFORMS

NOTES:

A. The input pulses are supplied by generators having the following characteristics: PRR ≤ 1 MHz, duty cycle ≤ 50%, $Z_{out} \approx 50\ \Omega$; $t_r \leq 15$ ns, $t_f \leq 6$ ns.

B. Enable P and enable T setup times are measured at $t_n = 0$.

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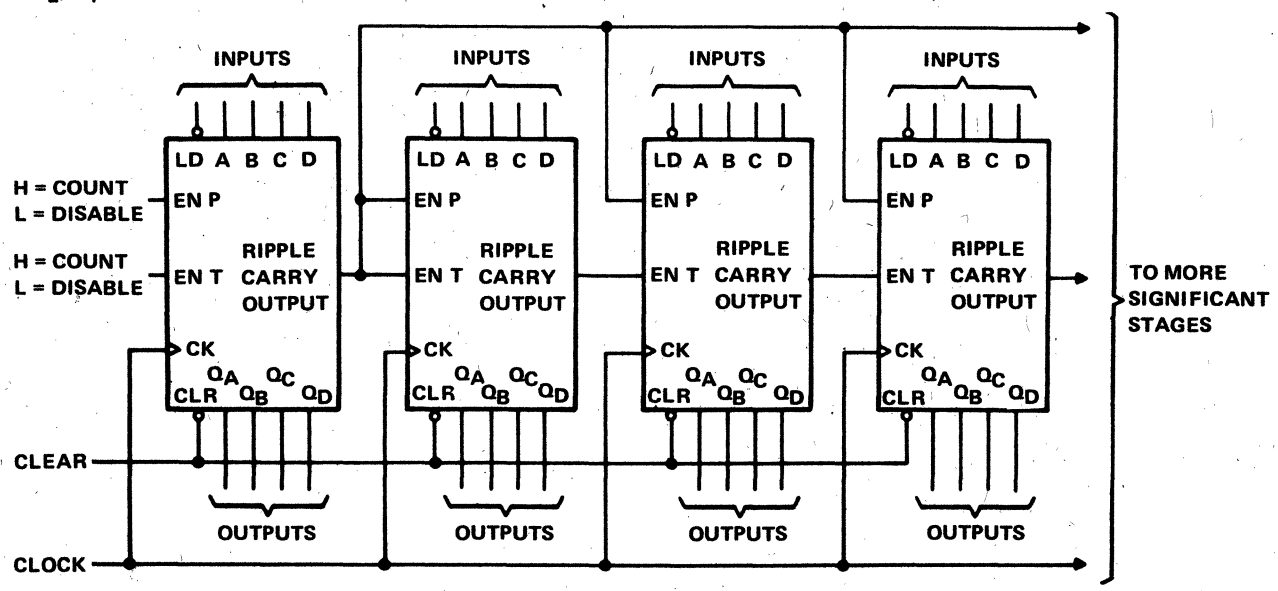
Synchronous BCD Decade Counters — 25LS160 25LS162
Synchronous 4-Bit Binary Counters — 25LS161 25LS163

TYPICAL APPLICATION DATA

N-BIT SYNCHRONOUS COUNTERS

This application demonstrates how the look-ahead carry circuit can be used to implement a high-speed n-bit counter. The 25LS160 or 25LS162 will count in BCD and the 25LS163 will count in binary. Virtually any count mode (modulo-N, N_1-to N_2, N_1-to-maximum) can be used with this fast look-ahead circuit.



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FEATURES

- **Provides 16 arithmetic operations**
- **Provides 16 logic operations**
- **Full look-ahead for high-speed arithmetic operation on long words**
- **Higher speed compared to 9LS/54LS and 9LS/74LS**
- **8mA sink current over full military temperature range**
- **50mV improved V_{OL} compared to 9LS/74LS**
- **440μA source current**
- **100% reliability assurance testing in compliance with MIL-STD-883.**

DESCRIPTION

The 25LS181 is an arithmetic logic unit (ALU)/function generator which has a complexity of 75 equivalent gates on a monolithic chip. This circuit performs 16 binary arithmetic operations on two 4-bit words as shown in Tables 1 and 2. These operations are selected by the four function-select lines (S0, S1, S2, S3) and include addition, subtraction, decrement, and straight transfer. When performing arithmetic manipulations, the internal carries must be enabled by applying a low-level voltage to the mode control input (M). A full carry look-ahead scheme is made available in these devices for fast, simultaneous carry generation by means of two cascade-outputs (pins 15 and 17) for the four bits in the package. When used in conjunction with the 182, full carry ahead look-ahead circuits, high-speed arithmetic operations can be performed.

If high speed is not of importance, a ripple-carry input (C_n) and a ripple-carry output (C_{n+4}) are available. However, the ripple-carry delay has also been minimized so that arithmetic manipulations for small word lengths can be performed without external circuitry.

The 25LS181 will accommodate active-high or active-low data if the pin designations are interpreted as follows:

Subtraction is accomplished by 1's complement addition where the 1's complement of the subtrahend is generated internally. The resultant output is A-B-1 which requires an end-around or forced carry to provide A-B.

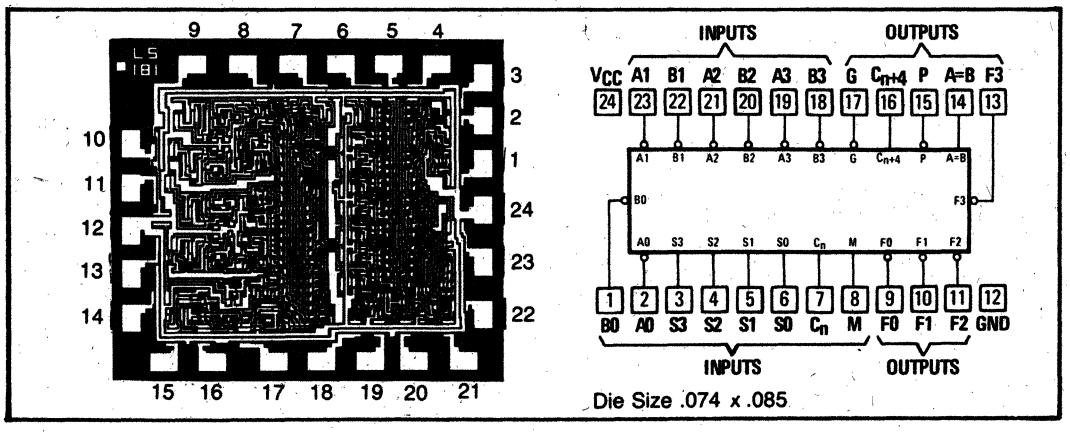
The 25LS181 can also be utilized as a comparator. The A = B output is internally decoded from the function outputs (F0, F1, F2, F3) so that when two words of equal magnitude are applied at the A and B inputs, it will assume a high level to indicate equality (A = B). The ALU should be in the subtract mode with C_n = H when performing this comparison. The A = B output is open-collector so that it can be wire-AND connected to give a comparison for more than four bits. The carry output (C_{n+4}) can also be used to supply relative magnitude information. Again, the ALU should be placed in the subtract mode by placing the function select inputs, S3, S2, S1, S0 at L, H, H, L, respectively.

INPUT $\overline{C}_n$	OUTPUT $\overline{C}_{n+4}$	ACTIVE-HIGH DATA (FIGURE 1)	ACTIVE-LOW DATA (FIGURE 2)
H	H	A < B	A ≥ B
H	L	A > B	A < B
L	H	A < B	A > B
L	L	A ≥ B	A ≤ B

These circuits have been designed to not only incorporate all of the designer's requirements for arithmetic operations, but also provide 16 possible functions of two Boolean variables without the use of external circuitry. These logic functions are selected by use of the four function-select inputs (S0, S1, S2, S3) with the mode-control input (M) at a high level to disable the internal carry. The 16 logic functions are detailed in Tables 1 and 2 and include exclusive-OR, NAND, AND, NOR, and OR functions.

PIN NUMBER	2	1	23	22	21	20	19	18	9	10	11	13	7	16	15	17
Active-high data (Table 1)	A_0	B_0	A_1	B_1	A_2	B_2	A_3	B_3	F_0	F_1	F_2	F_3	$\overline{C}_n$	$\overline{C}_{n+4}$	X	Y
Active-low data (Table 2)	$\overline{A}_0$	$\overline{B}_0$	$\overline{A}_1$	$\overline{B}_1$	$\overline{A}_2$	$\overline{B}_2$	$\overline{A}_3$	$\overline{B}_3$	$\overline{F}_0$	$\overline{F}_1$	$\overline{F}_2$	$\overline{F}_3$	C_n	C_{n+4}	$\overline{P}$	$\overline{G}$

PIN-OUT DIAGRAM



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4-Bit Arithmetic Logic Unit

ALU SIGNAL DESIGNATIONS

The 25LS181 can be used with the signal designations of either Figure 1 or Figure 2.

The logic functions and arithmetic operations obtained with signal designations as in Figure 1 are given in Table 1; those obtained with the signal designations of Figure 2 are given in Table 2.

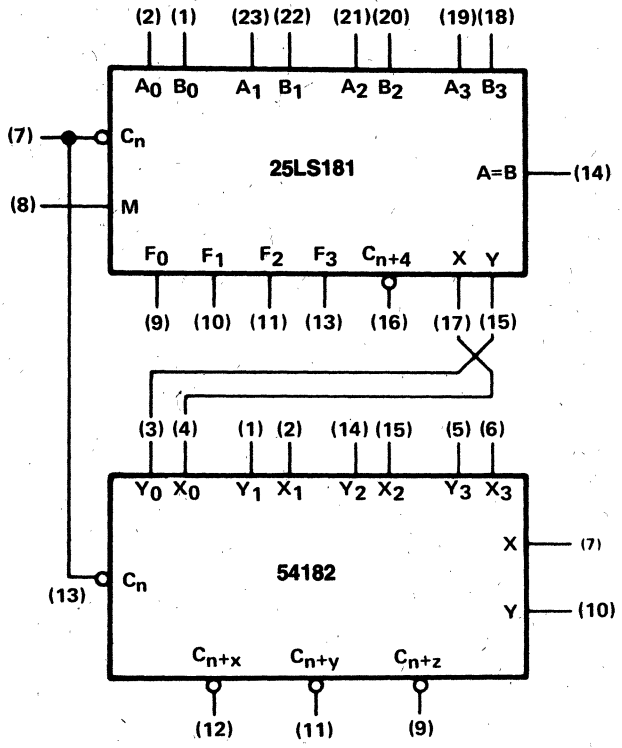

FIGURE 1
(FOR TABLE 1)

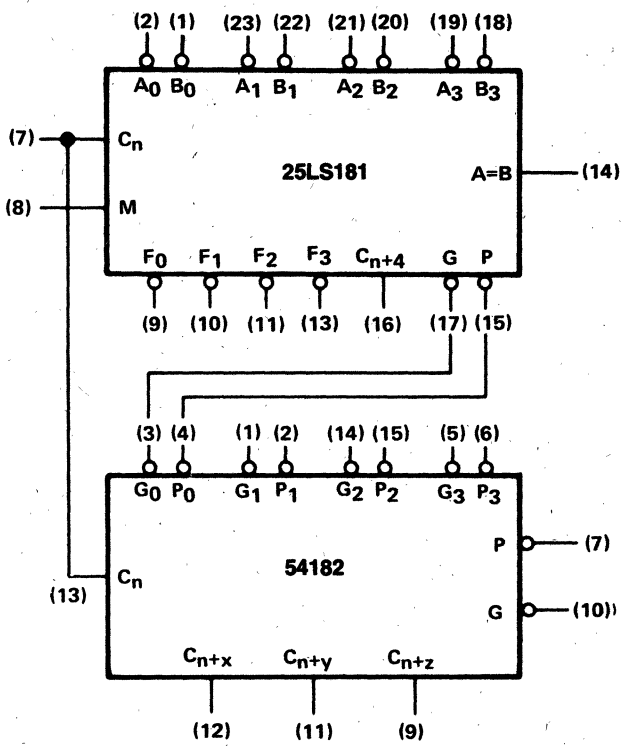

FIGURE 2
(FOR TABLE 2)

TABLE 1

SELECTION S3 S2 S1 S0	ACTIVE-HIGH DATA		
	M = H	M = L; ARITHMETIC OPERATIONS	
	LOGIC FUNCTIONS	C_n = H (no carry)	C_n = L (no carry)
L L L L	F = $\overline{A}$	F = A	F = A PLUS 1
L L L H	F = $\overline{A+B}$	F = A + B	F = (A + B) PLUS 1
L L H L	F = $\overline{A}B$	F = A + $\overline{B}$	F = (A + $\overline{B}$) PLUS 1
L L H H	F = 0	F = MINUS 1 (2's COMPL)	F = ZERO
L H L L	F = $\overline{AB}$	F = A PLUS A$\overline{B}$	F = A PLUS A$\overline{B}$ PLUS 1
L H L H	F = $\overline{B}$	F = (A + B) PLUS A$\overline{B}$	F = (A + B) PLUS A$\overline{B}$ PLUS 1
L H H L	F = A ⊕ B	F = A MINUS B MINUS 1	F = A MINUS B
L H H H	F = A$\overline{B}$	F = A$\overline{B}$ MINUS 1	F = A$\overline{B}$
H L L L	F = $\overline{A}$ + B	F = A PLUS AB	F = A PLUS AB PLUS 1
H L L H	F = $\overline{A \oplus B}$	F = A PLUS B	F = A PLUS B PLUS 1
H L H L	F = B	F = (A + $\overline{B}$) PLUS AB	F = (A + $\overline{B}$) PLUS AB PLUS 1
H L H H	F = AB	F = AB MINUS 1	F = AB
H H L L	F = 1	F = A PLUS A*	F = A PLUS A PLUS 1
H H L H	F = A + $\overline{B}$	F = (A + B) PLUS A	F = (A + B) PLUS A PLUS 1
H H H L	F = A + B	F = (A + $\overline{B}$) PLUS A	F = (A + $\overline{B}$) PLUS A PLUS 1
H H H H	F = A	F = A MINUS 1	F = A

TABLE 2

SELECTION S3 S2 S1 S0	ACTIVE-LOW DATA		
	M = H	M = L; ARITHMETIC OPERATIONS	
	LOGIC FUNCTIONS	C_n = L (with carry)	C_n = H (with carry)
L L L L	F = $\overline{A}$	F = A MINUS 1	F = A
L L L H	F = $\overline{AB}$	F = AB MINUS 1	F = AB
L L H L	F = $\overline{A}$ + B	F = A$\overline{B}$ MINUS 1	F = A$\overline{B}$
L L H H	F = 1	F = MINUS 1 (2's COMP)	F = ZERO
L H L L	F = $\overline{A+B}$	F = A PLUS (A + $\overline{B}$)	F = A PLUS (A + $\overline{B}$) PLUS 1
L H L H	F = $\overline{B}$	F = AB PLUS (A + $\overline{B}$)	F = AB PLUS (A + $\overline{B}$) PLUS 1
L H H L	F = $\overline{A \oplus B}$	F = A MINUS B MINUS 1	F = A MINUS B
L H H H	F = A + $\overline{B}$	F = A + $\overline{B}$	F = (A + $\overline{B}$) PLUS 1
H L L L	F = $\overline{A}$B	F = A PLUS (A + B)	F = A PLUS (A + B) PLUS 1
H L L H	F = A ⊕ B	F = A PLUS B	F = A PLUS B PLUS 1
H L H L	F = B	F = A$\overline{B}$ PLUS (A + B)	F = A$\overline{B}$ PLUS (A + B) PLUS 1
H L H H	F = A + B	F = A + B	F = (A + B) PLUS 1
H H L L	F = 0	F = A PLUS A*	F = A PLUS A PLUS 1
H H L H	F = A$\overline{B}$	F = AB PLUS A	F = AB PLUS A PLUS 1
H H H L	F = AB	F = A$\overline{B}$ PLUS A	F = A$\overline{B}$ PLUS A PLUS 1
H H H H	F = A	F = A	F = A PLUS 1

*Each bit is shifted to the next more significant position.

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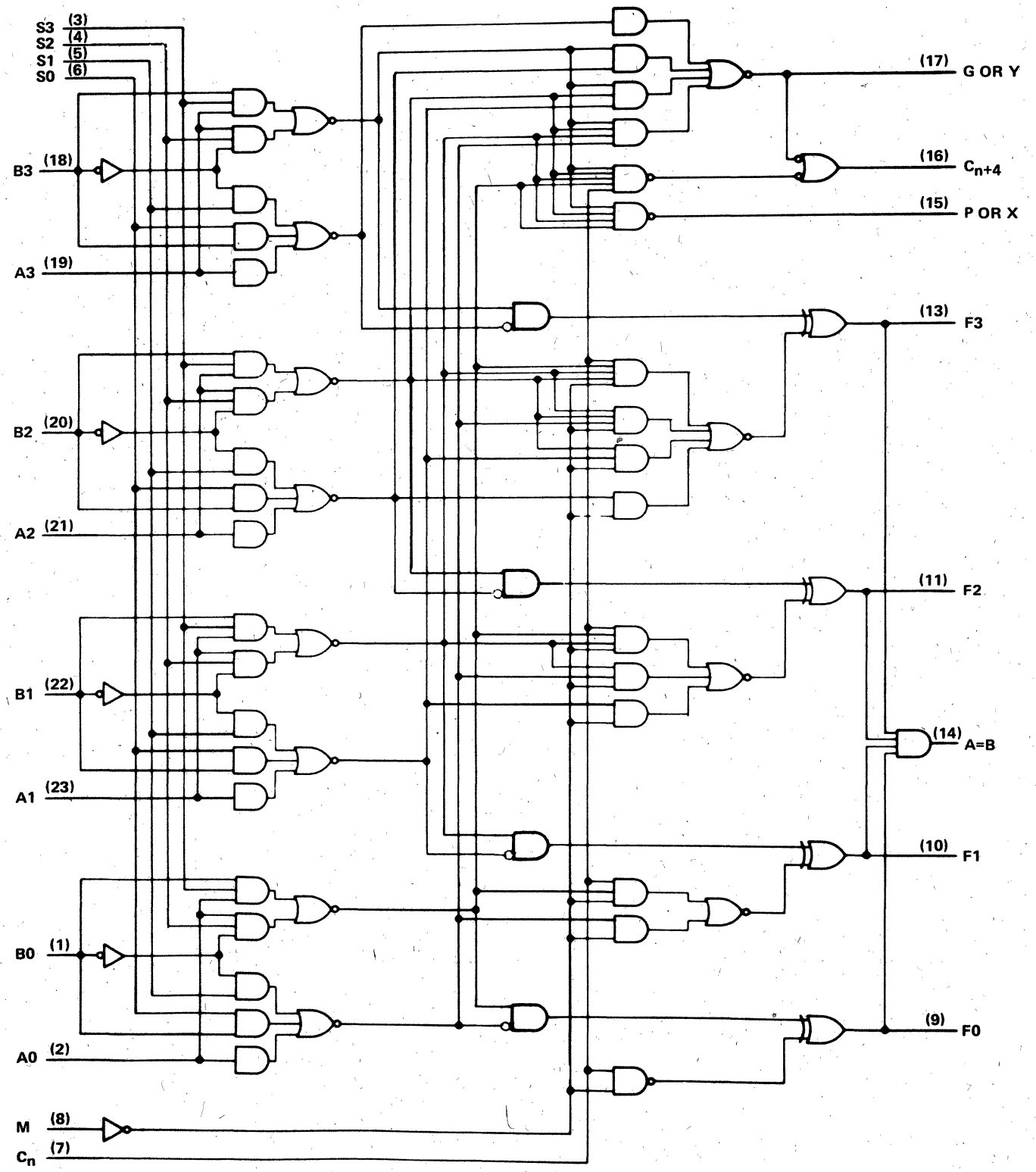
LOGIC DIAGRAM



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4-Bit Arithmetic Logic Unit

25LS181

Recommended Operating Conditions

	Military			Commercial			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH} (All outputs except A = B)			-440			-440	μA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		Military			Commercial			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	Any Output except A = B	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-400μA		2.5	3.4		2.7	3.4		V
I_{OH}	A = B Output only	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, V_I=V_{IH} or V_{IL}				100			100	μA
V_{OL}	All outputs	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max V_I=V_{IH} or V_{IL}	I_{OL}=4mA			0.40			0.40	V
			I_{OL}=8mA			0.45			0.45	
	Output G		I_{OL}=16mA(G)			0.55			0.55	
I_I	Mode input	V_{CC}=MAX, V_I = 5.5V				0.1			0.1	mA
	Any $\overline{A}$ or $\overline{B}$ input					0.3			0.3	
	Any S input					0.4			0.4	
	Carry input					0.5			0.5	
I_{IH}	Mode input	V_{CC}=MAX, V_I=2.7V				20			20	μA
	Any $\overline{A}$ or $\overline{B}$					60			60	
	Any S input					80			80	
	Carry input					100			100	
I_{IL}	Mode input	V_{CC}=MAX, V_I = 0.5V				-0.36			-0.36	mA
	Any $\overline{A}$ or $\overline{B}$ input					-1.08			-1.08	
	Any S input					-1.44			-1.44	
	Carry input					-2			-2	
I_{OS}†	Any Output except A=B	V_{CC}=MAX		-15		-85	-15		-85	mA
I_{CC}††		V_{CC}=MAX	Condition A		20	32		20	34	mA
			Condition B		21	35		21	37	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

††With outputs open, I_{CC} is measured for the following conditions:

A. S0 through S3, M and A inputs are at 4.5V, all other inputs are grounded.

B. S0 through S3 and M are at 4.5V, all other inputs are grounded.

RAYTHEON
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Switching Characteristics, V_{CC} = 5V, T_A = +25°C

Parameter ¶	From (input)	To (output)	+25°C Min	+25°C Typ	+25°C Max	Unit
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A on page 2-147)						
t_{PLH}	C_n	C_{n+4}		14	25	ns
t_{PHL}				13	14	
M = 0V, S0 = S3 = 4.5V, S1 = S2 = 0V ($\overline{SUM}$ mode)						
t_{PLH}	Any A or B	C_{n+4}		24	33	ns
t_{PHL}				17	31	
M = 0V, S0 = S3 = 0V, S1 = S2 = 4.5V ($\overline{DIFF}$ mode)						
t_{PLH}	Any A or B	C_{n+4}		24	35	ns
t_{PHL}				29	35	
M = 0V, ($\overline{SUM}$ or $\overline{DIFF}$ mode)						
t_{PLH}	C_n	Any F		12	19	ns
t_{PHL}				12	18	
M = 0V, S0 = S3 = 4.5V, S1 = S2 = 0V ($\overline{SUM}$ mode)						
t_{PLH}	Any A or B	G		12	25	ns
t_{PHL}				15	23	
M = 0V, S0 = S3 = 0V, S1 = S2 = 4.5V ($\overline{DIFF}$ mode)						
t_{PLH}	Any A or B	G		20	25	ns
t_{PHL}				17	25	
M = 0V, S0 = S3 = 4.5V, S1 = S2 = 4.5V ($\overline{SUM}$ mode)						
t_{PLH}	Any A or B	P		14	26	ns
t_{PHL}				20	26	
M = 0V, S0 = S3 = 0V, S1 = S2 = 4.5V ($\overline{DIFF}$ mode)						
t_{PLH}	Any A or B	P		24	30	ns
t_{PHL}				22	26	
M = 0V, S0 = S3 = 4.5V, S1 = S2 = 0V ($\overline{SUM}$ mode)						
t_{PLH}	A_i or B_i	F_i		15	28	ns
t_{PHL}				13	19	
M = 0V, S0 = S3 = 0V, S1 = S2 = 4.5V ($\overline{DIFF}$ mode)						
t_{PLH}	A_i or B_i	F_i		24	30	ns
t_{PHL}				15	19	
M = 4.5V (logic mode)						
t_{PLH}	A_i or B_i	F_i		17	31	ns
t_{PHL}				15	25	
M = 0V, S0 = S3 = 0V, S1 = S2 = 4.5V ($\overline{DIFF}$ mode)						
t_{PLH}	Any A or B	A = B		33	50	ns
t_{PHL}				29	45	

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4-Bit Arithmetic Logic Unit

PARAMETER MEASUREMENT INFORMATION

$\overline{SUM}$ MODE TEST TABLE

FUNCTION INPUTS: S0 = S3 = 4.5 V, S1 = S2 = M = 0 V

PARAMETER	INPUT UNDER TEST	OTHER INPUT SAME BIT		OTHER DATA INPUTS		OUTPUT UNDER TEST	OUTPUT WAVEFORM
		APPLY 4.5 V	APPLY GND	APPLY 4.5 V	APPLY GND		
t_{PLH}	A_i	B_i	None	Remaining A and B	C_n	F_i	In-Phase
t_{PHL}							
t_{PLH}	B_i	A_i	None	Remaining A and B	C_n	F_i	In-Phase
t_{PHL}							
t_{PLH}	A_i	B_i	None	None	Remaining A and B, C_n	P	In-Phase
t_{PHL}							
t_{PLH}	B_i	A_i	None	None	Remaining A and B, C_n	P	In-Phase
t_{PHL}							
t_{PLH}	A_i	None	B_i	Remaining B	Remaining A, C_n	G	In-Phase
t_{PHL}							
t_{PLH}	B_i	None	A_i	Remaining B	Remaining A, C_n	G	In-Phase
t_{PHL}							
t_{PLH}	C_n	None	None	All A	All B	Any F or C_{n+4}	In-Phase
t_{PHL}							
t_{PLH}	A_i	None	B_i	Remaining B	Remaining A, C_n	C_{n+4}	Out-of-Phase
t_{PHL}							
t_{PLH}	B_i	None	A_i	Remaining B	Remaining A, C_n	C_{n+4}	Out-of-Phase
t_{PHL}							

$\overline{DIFF}$ MODE TEST TABLE

FUNCTION INPUTS: S1 = S2 = 4.5 V, S0 = S3 = M = 0 V

PARAMETER	INPUT UNDER TEST	OTHER INPUT SAME BIT		OTHER DATA INPUTS		OUTPUT UNDER TEST	OUTPUT WAVEFORM
		APPLY 4.5 V	APPLY GND	APPLY 4.5 V	APPLY GND		
t_{PLH}	A_i	None	B_i	Remaining A	Remaining B, C_n	F_i	In-Phase
t_{PHL}							
t_{PLH}	B_i	A_i	None	Remaining A	Remaining B, C_n	F_i	Out-of-Phase
t_{PHL}							
t_{PLH}	A_i	None	B_i	None	Remaining A and B, C_n	P	In-Phase
t_{PHL}							
t_{PLH}	B_i	A_i	None	None	Remaining A and B, C_n	P	Out-of-Phase
t_{PHL}							
t_{PLH}	A_i	B_i	None	None	Remaining A and B, C_n	G	In-Phase
t_{PHL}							
t_{PLH}	B_i	None	A_i	None	Remaining A and B, C_n	G	Out-of-Phase
t_{PHL}							
t_{PLH}	A_i	None	B_i	Remaining A	Remaining B, C_n	A = B	In-Phase
t_{PHL}							
t_{PLH}	B_i	A_i	None	Remaining A	Remaining B, C_n	A = B	Out-of Phase
t_{PHL}							
t_{PLH}	C_n	None	None	All A and B	None	C_{n+4} or any F	In-Phase
t_{PHL}							
t_{PLH}	A_i	B_i	None	None	Remaining A, B, C_n	C_{n+4}	Out-of-Phase
t_{PHL}							
t_{PLH}	B_i	None	A_i	None	Remaining A, B, C_n	C_{n+4}	In-Phase
t_{PHL}							

LOGIC MODE TEST TABLE

FUNCTION INPUTS: S1 = S2 = M = 4.5 V, S0 = S3 = 0 V

PARAMETER	INPUT UNDER TEST	OTHER INPUT SAME BIT		OTHER DATA INPUTS		OUTPUT UNDER TEST	OUTPUT WAVEFORM
		APPLY 4.5 V	APPLY GND	APPLY 4.5 V	APPLY GND		
t_{PLH}	A_i	B_i	None	None	Remaining A and B, C_n	F_i	Out-of-Phase
t_{PHL}							
t_{PLH}	B_i	A_i	None	None	Remaining A and B, C_n	F_i	Out-of-Phase
t_{PHL}							

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25LS190 Synchronous BCD Decade Up/Down Counter

25LS191 Synchronous 4-Bit Binary Up/Down Counter

FEATURES

- Single up/down count mode control line
- Asynchronous parallel load
- Count enable, parallel load control inputs
- Cascadable
- Higher speed compared to 9LS/54LS and 9LS/74LS
- 8mA sink current over full military temperature range
- 50mV improved V_{OL} compared to 9LS/74LS
- 440μA source current
- 100% reliability assurance testing in compliance with MIL-STD-883

DESCRIPTION

The 25LS190 and 25LS191 are synchronous, reversible up/down counters having a complexity of 58 equivalent gates. The 25LS191 is a 4-bit binary counter and the 25LS190 is a BCD counter. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the steering logic. This mode of operation eliminates the output counting spikes normally associated with asynchronous (ripple clock) counters.

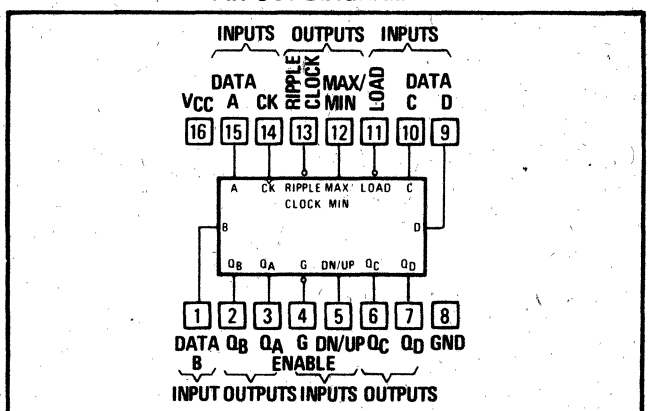
The outputs of the four master-slave flip-flops are triggered on a low-to-high-level transition of the clock input if the enable input is low. A high at the enable input inhibits counting. Level changes at the enable and down/up inputs should be made only when the clock input is high. The direction of the count is determined by the level of the down/up input. When low, the counter counts up and when high, it counts down.

These counters are fully programmable; that is, the outputs may be preset to either level by placing a low on the load input and entering the desired data at the data inputs. The output will change to agree with the data inputs independently of the level of the clock input. This feature allows the counters to be used as modulo-N dividers by simply modifying the count length with the preset inputs.

The clock, down/up, and load inputs are buffered to lower the drive requirement which significantly reduces the number of clock drivers, etc., required for long parallel words.

Two outputs have been made available to perform the cascading function: ripple clock and maximum/minimum count. The latter output produces a high-level output pulse with a duration approximately equal to one complete cycle of the clock when the counter overflows or underflows. The ripple clock output produces a low-level output pulse equal in width to the low-level portion of the clock input when an overflow or underflow condition exists. The counters can be easily cascaded by feeding the ripple clock output to the enable input of the succeeding counter if parallel clocking is used, or to the clock input if parallel enabling is used. The maximum/minimum count output can be used to accomplish look-ahead for high-speed operation.

PIN-OUT DIAGRAM



LOW INPUT TO LOAD SETS Q_A = A, Q_B = B, Q_C = C, Q_D = D

Recommended Operating Conditions

	Military			Commercial			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-440			-440	μA
Low-level output current, I_{OL}			4			8	mA
Input clock frequency, f_{clock}	0		25	0		25	MHz
Width of clock input pulse, $t_{w(clock)}$	25			25			ns
Width of load input pulse, $t_{w(load)}$	25			25			ns
Data setup time, t_{setup} (see Figures 1 and 2)	12			12			ns
Enable to clock setup time, t_{setup}	20			20			ns
Data hold time, t_{hold}	0			0			ns
Operating free-air temperature, T_A	-55		125	0		70	°C

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Synchronous BCD Decade Up/Down Counter — 25LS190
Synchronous 4-Bit Binary Up/Down Counter — 25LS191

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		Military			Commercial			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-440μA		2.5	3.4		2.7	3.4		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.40		0.25	0.40	V
			I_{OL}=8mA		0.30	0.45		0.30	0.45	
I_I	Enable	V_{CC}=MAX, V_I=7V				0.3			0.3	mA
	Others					0.1			0.1	
I_{IH}	Enable	V_{CC}=MAX, V_I=2.7V				60			60	μA
	Others					20			20	
I_{IL}	Enable	V_{CC}=MAX, V_I=0.4V				-1.08			-1.08	mA
	Others					-0.4			-0.4	
I_{OS}†		V_{CC}=MAX		-15		-85	-15		-85	mA
I_{CC}††		V_{CC}=MAX			20	35		20	35	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
††I_{CC} is measured with all inputs grounded and all outputs open.

Switching Characteristics, V_{CC} = T_A = +25°C

Parameter	From (input)	To (output)	+25°C			Unit
			Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. 1 and 3 thru 7 on pages 2-99 and 2-100)						
f_{max}			25	35		MHz
t_{PLH}	Load	Q_A,Q_B,Q_C,Q_D		22	33	ns
t_{PHL}				30	39	
t_{PLH}	Data A,B,C,D	Q_A,Q_B,Q_C,Q_D		13	22	ns
t_{PHL}				29	39	
t_{PLH}	Clock	Ripple Clock		11	18	ns
t_{PHL}				14	21	
t_{PLH}	Clock	Q_A,Q_B,Q_C,Q_D		15	21	ns
t_{PHL}				16	30	
t_{PLH}	Clock	Max/Min		23	39	ns
t_{PHL}				22	39	
t_{PLH}	Down/Up	Ripple Clock		16	45	ns
t_{PHL}				25	45	
t_{PLH}	Down/Up	Max/Min		17	33	ns
t_{PHL}				12	33	
t_{PLH}	Enable	Ripple Clock		10	19	ns
t_{PHL}				14	27	

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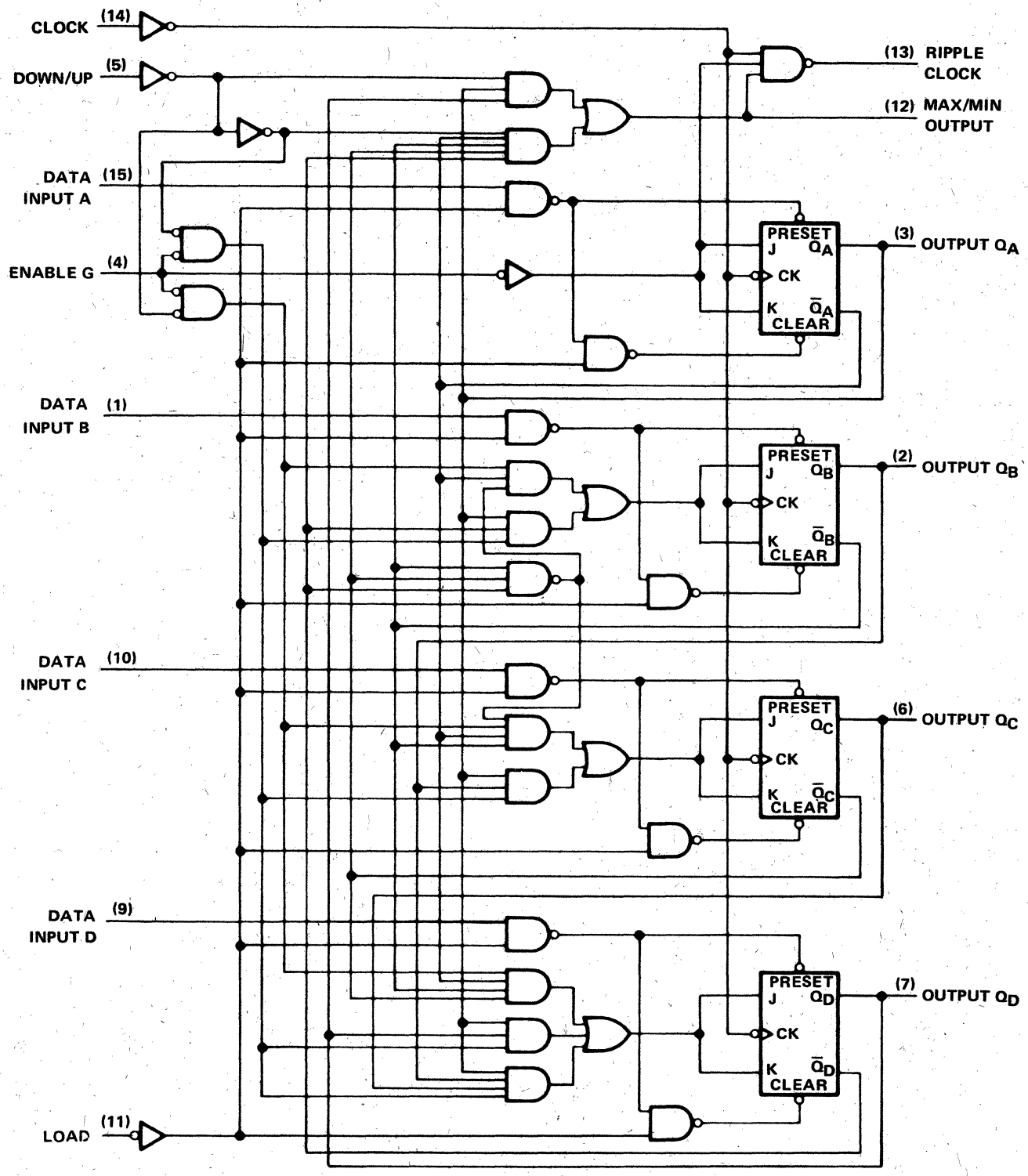
LOGIC DIAGRAM

25LS190



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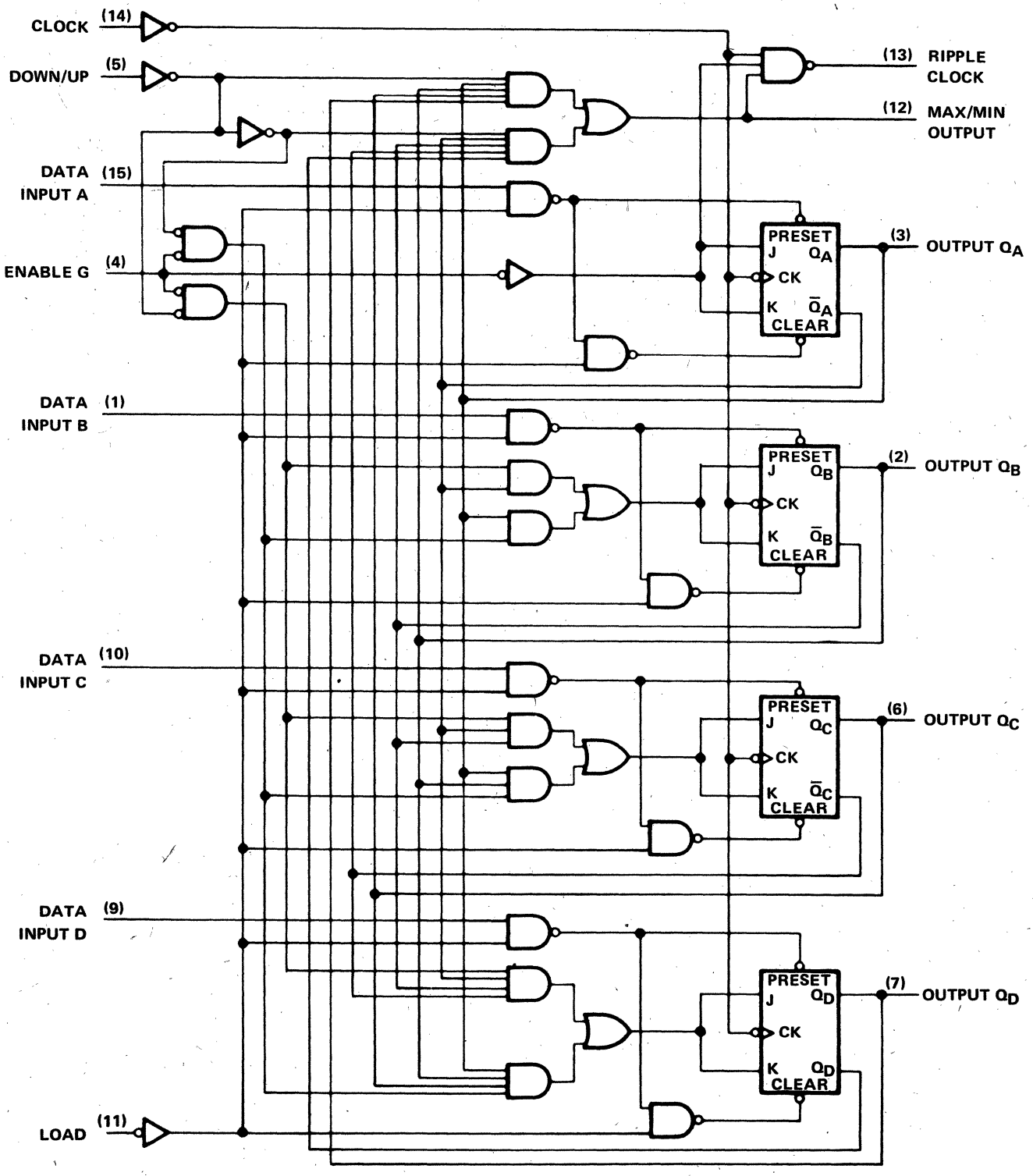
Synchronous BCD Decade Up/Down Counter — 25LS190

Synchronous 4-Bit Binary Up/Down Counter — 25LS191

LOGIC DIAGRAM
25LS191



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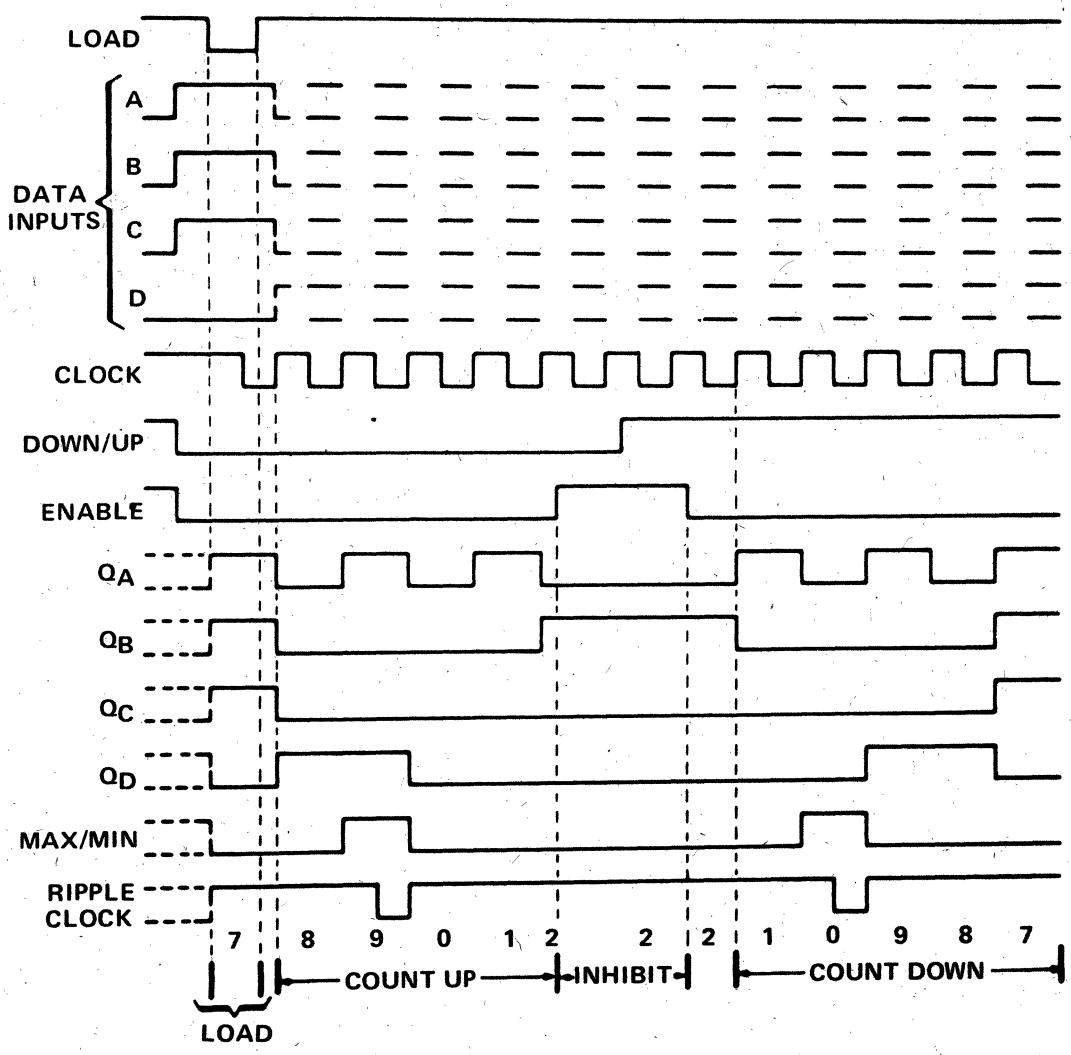
25LS190 TYPICAL LOAD, COUNT AND INHIBIT SEQUENCES

Illustrated below is the following sequence:

1. Load (preset) to BCD seven.
2. Count up to eight, nine (maximum), zero, one, and two.
3. Inhibit.
4. Count down to one, zero (minimum), nine, eight, and seven.



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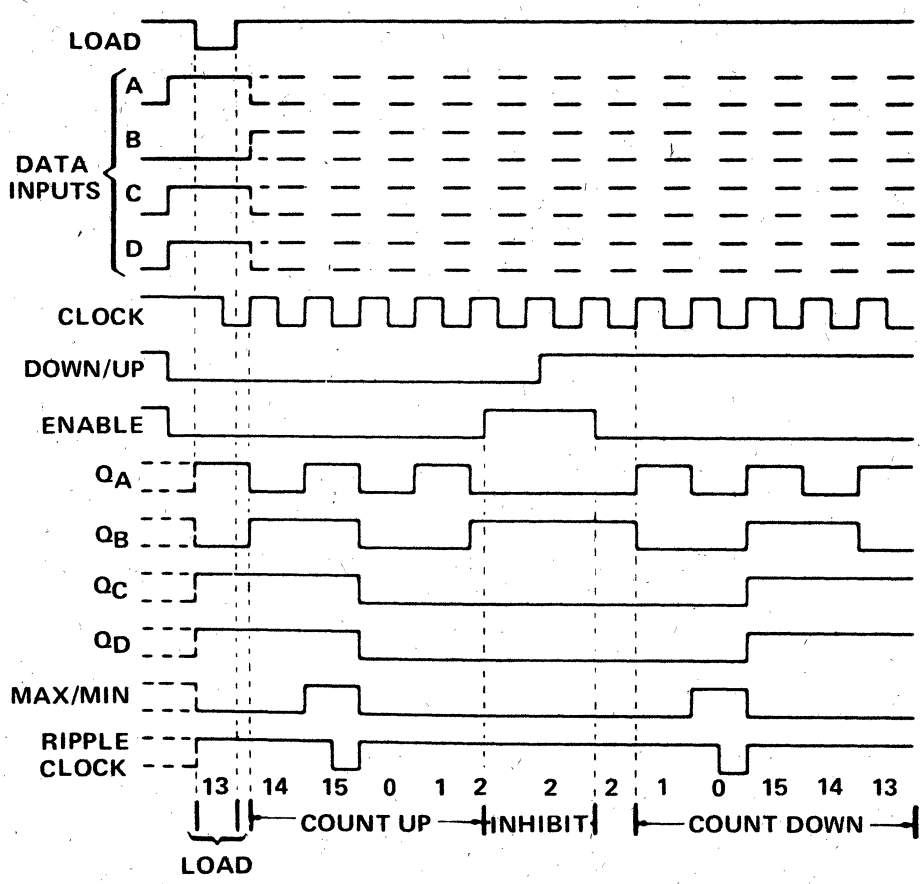
Synchronous BCD Decade Up/Down Counter — 25LS190
Synchronous 4-Bit Binary Up/Down Counter — 25LS191

25LS191 TYPICAL LOAD, COUNT AND INHIBIT SEQUENCES

Illustrated below is the following sequence:

1. Load (preset) to binary thirteen.
2. Count up to fourteen, fifteen (maximum), zero, one, and two.
3. Inhibit.
4. Count down to one, zero (minimum), fifteen, fourteen, and thirteen.



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PARAMETER MEASUREMENT INFORMATION

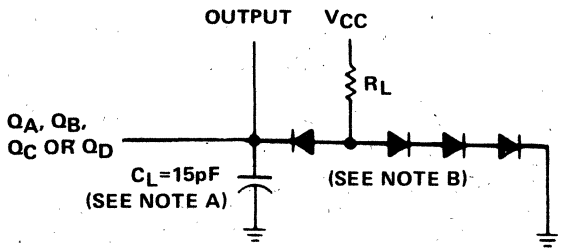


FIGURE 1–LOAD CIRCUIT
FOR SWITCHING TIME MEASUREMENT

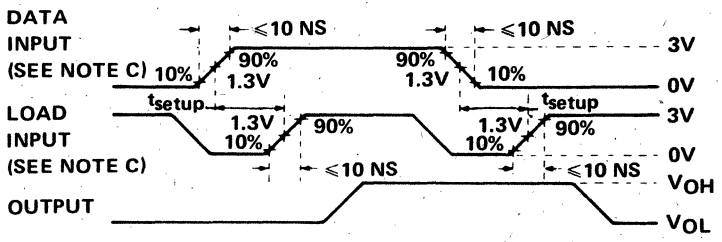
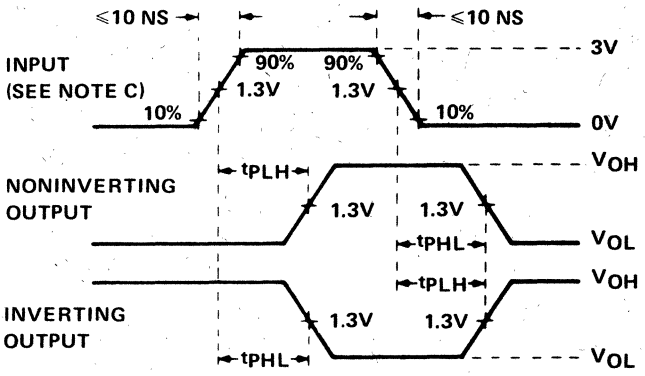


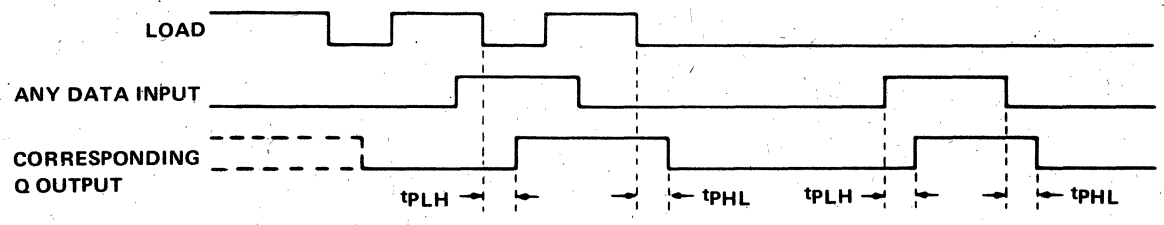
FIGURE 2–DATA SETUP TIME VOLTAGE WAVEFORMS

See waveform sequences in Figures 4 through 7 for propagation times from a specific input to a specific output. For simplification, pulse rise times, reference levels, etc., have not been shown in Figures 4 through 7.

FIGURE 3– GENERAL VOLTAGE WAVEFORMS
FOR PROPAGATION TIMES

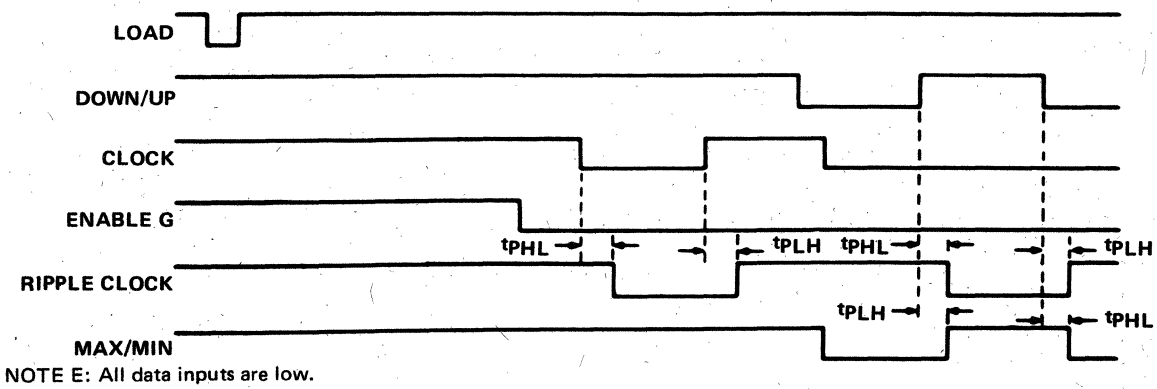


NOTES:
A. C_L includes probe and jig capacitance.
B. All diodes are 1N3064.
C. The input pulses are supplied by generators having the following characteristics: Z_{out} = 50Ω, duty cycle ≤ 50%, PRR ≤ 1MHz.



NOTE D: Conditions on other inputs are irrelevant.

FIGURE 4–LOAD TO OUTPUT AND DATA TO OUTPUT



NOTE E: All data inputs are low.

FIGURE 5–ENABLE TO RIPPLE CLOCK, CLOCK TO RIPPLE CLOCK, DOWN/UP TO MAX/MIN

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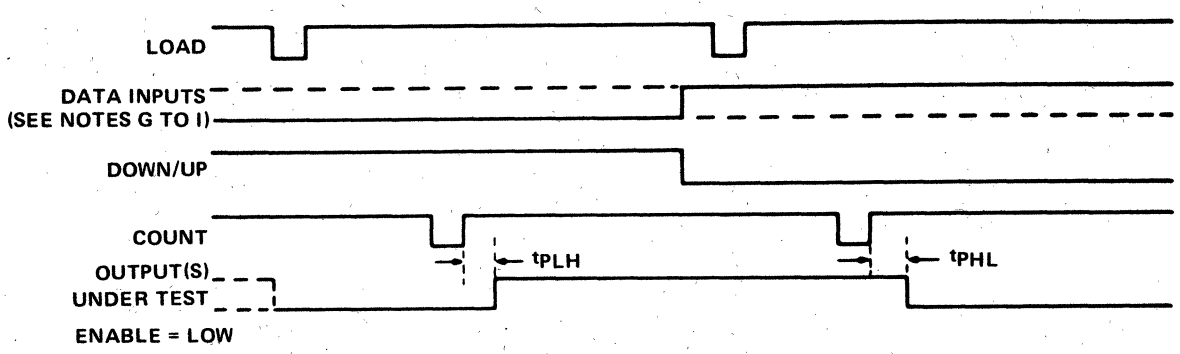
Synchronous BCD Decade Up/Down Counter 25LS192

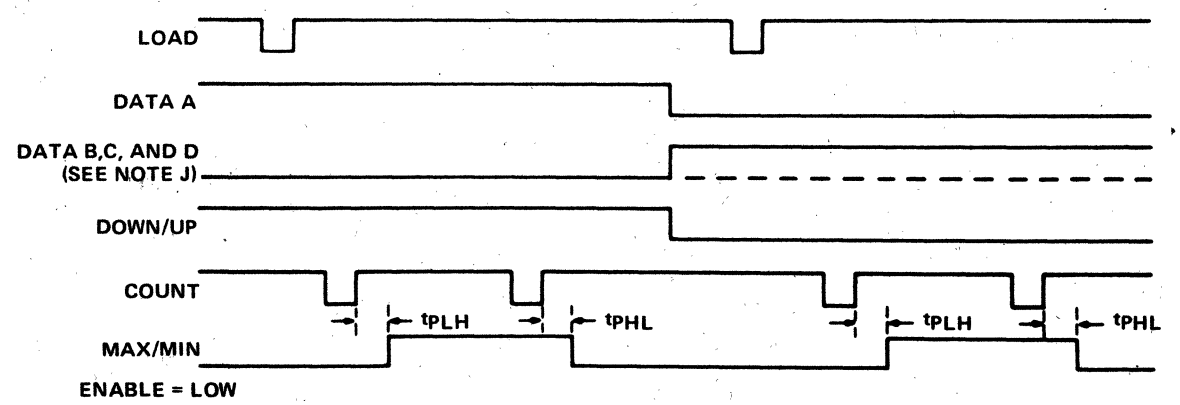
Synchronous 4-Bit Binary Up/Down Counter 25LS193

PARAMETER MEASUREMENT INFORMATION (Continued)



NOTES:
F. To test Q_A, Q_B, and Q_C outputs of 25LS190: Data inputs A, B, and C are shown by the solid line. Data input D is shown by the dashed line.
G. To test Q_D output of 25LS190: Data inputs A and D are shown by the solid line. Data inputs B and C are held at the low logic level.
H. To test Q_A, Q_B, Q_C, and Q_D outputs of 54LS191: All four data inputs are shown by the solid line.

FIGURE 6–CLOCK TO OUTPUT



NOTE I:
Data inputs B and C are shown by the dashed line for the 25LS190 and the solid line for the 25LS191: Data input D is shown by the solid line for both devices.

FIGURE 7–CLOCK TO MAX/MIN

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25LS190 Synchronous BCD Decade Up/Down Counter
25LS191 Synchronous 4-Bit Binary Up/Down Counter

FEATURES

- **Separate clock inputs for count-up, count-down**
- **Asynchronous parallel load and clear**
- **Cascadable**
- **Higher speed compared to 9LS/54LS and 9LS/74LS**
- **8mA sink current over full military temperature range**
- **50mV improved V_{OL} compared to 9LS/74LS**
- **440μA source current**
- **100% reliability assurance testing in compliance with MIL-STD-883.**

DESCRIPTION

These monolithic circuits are synchronous reversible (up/down) counters having a complexity of 55 equivalent gates. The 25LS192 is a BCD counter and the 25LS193 is a 4-bit binary counter. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincidently with each other when so instructed by the steering logic. This mode of operation eliminates the output counting spikes which are normally associated with asynchronous (ripple-clock) counters.

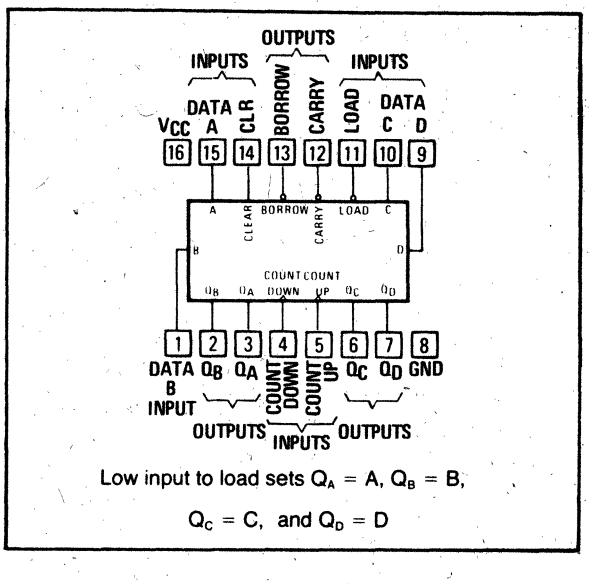
The outputs of the four master-slave flip-flops are triggered by a low-to-high-level transition of either count (clock) input. The direction of counting is determined by which count input is pulsed while the other count input is high.

All four counters are fully programmable; that is, each output may be preset to either level by entering the desired data at the data inputs while the load input is low. The output will change to agree with the data inputs independently of the count pulses. This feature allows the counters to be used as modulo-N dividers by simply modifying the count length with the preset inputs.

A clear input has been provided which forces all outputs to the low level when a high level is applied. The clear function is independent of the count and load inputs. The clear, count, and load inputs are buffered to lower the drive requirements. This reduces the number of clock drivers, etc., required for long words.

These counters were designed to be cascaded without the need for external circuitry. Both borrow and carry outputs are available to cascade both the up- and down-counting functions. The borrow output produces a pulse equal in width to the count-down input when the counter underflows. Similarly, the carry output produces a pulse equal in width to the count-down input when an overflow condition exists. The counters can then be easily cascaded by feeding the borrow and carry outputs to the count-down and count-up inputs respectively of the succeeding counter.

PIN-OUT DIAGRAM



Low input to load sets Q_A = A, Q_B = B, Q_C = C, and Q_D = D

Recommended Operating Conditions

	Military			Commercial			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-440			-440	μA
Low-level output current, I_{OL}			4			8	mA
Count frequency, f_{count}	0		25	0		25	MHz
Width of any input pulse, t_w	20			20			ns
Data setup time, t_{setup} (see Figure 1)	20			20			ns
Data hold time, t_{hold}	0			0			ns
Operating free-air temperature range, T_A	-55		125	0		70	°C

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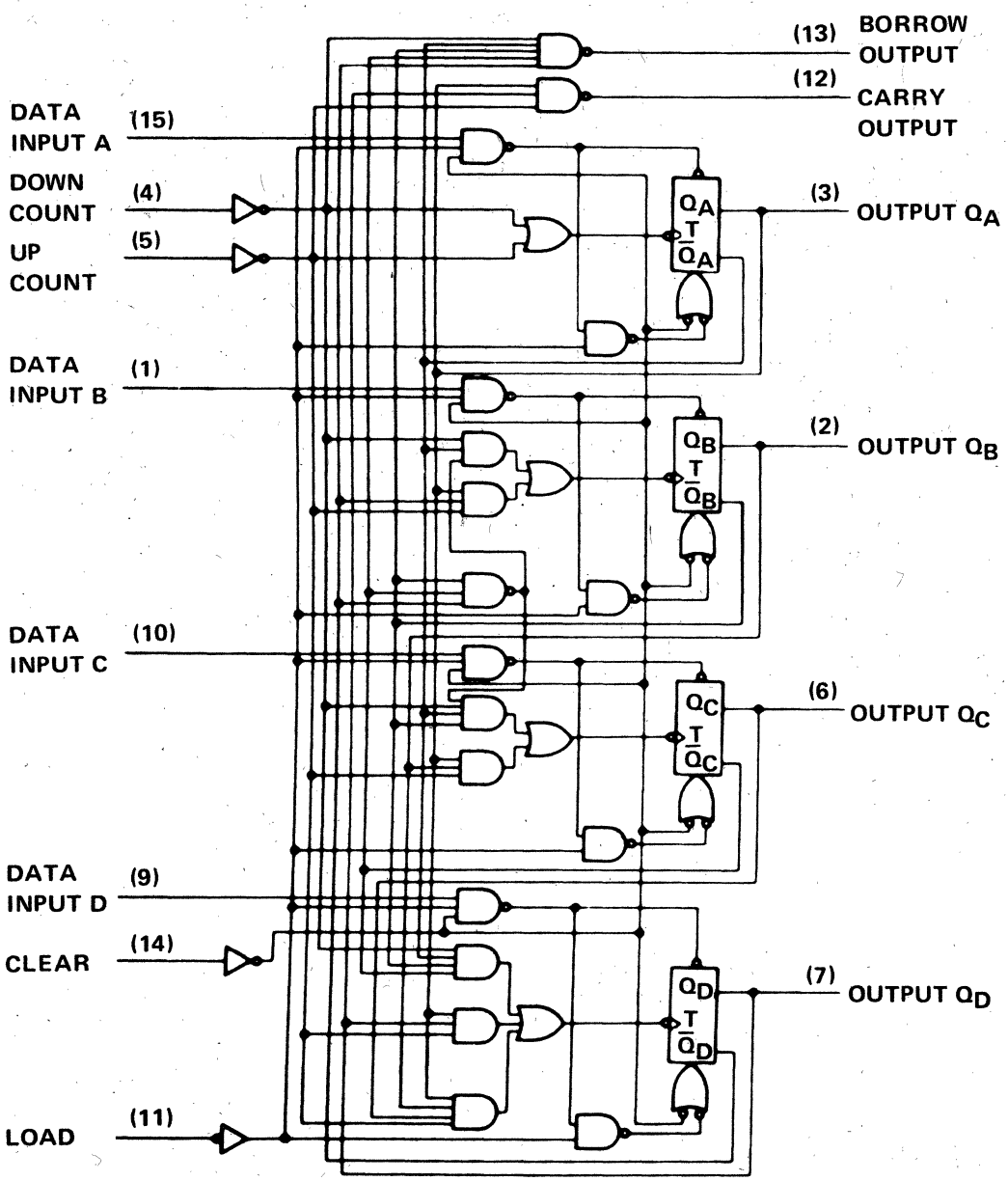
Synchronous BCD Decade Up/Down Counter — 25LS192
Synchronous 4-Bit Binary Up/Down Counter — 25LS193

LOGIC DIAGRAM

25LS192



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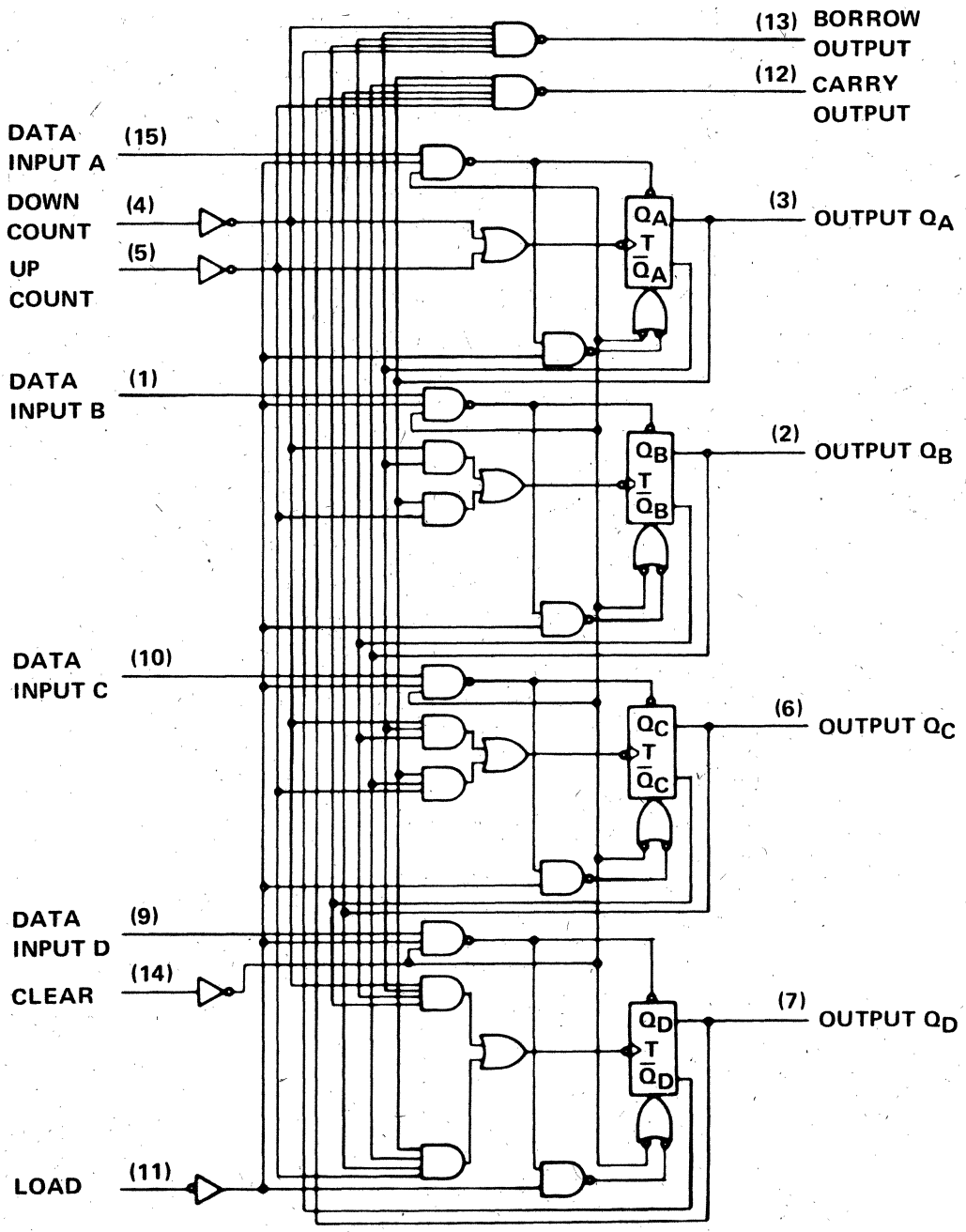
LOGIC DIAGRAM
25LS193



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Synchronous BCD Decade Up/Down Counter 25LS192

Synchronous 4-Bit Binary Up/Down Counter 25LS193

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		Military			Commercial			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-440μA		2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.40		0.25	0.40	V
		I_{OL}=8mA		0.30	0.45		0.30	0.45	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.4			-0.4	mA
I_{OS}†	V_{CC}=MAX		-15		-85	-15		-85	mA
I_{CC}††	V_{CC}=MAX			19	34		19	34	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
††I_{CC} is measured with all inputs grounded and all outputs open.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameters	From (input)	To (output)	+25°C			Unit
			Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. 1 & 2)						
f_{max}			25	35		MHz
t_{PLH}	Count-up	Carry		9	18	ns
t_{PHL}				17	24	
t_{PLH}	Count-down	Borrow		9	18	ns
t_{PHL}				17	24	
t_{PLH}	Either Count	Q		19	30	ns
t_{PHL}				20	32	
t_{PLH}	Load	Q		22	33	ns
t_{PHL}				29	40	
t_{PHL}	Clear	Q		23	33	ns

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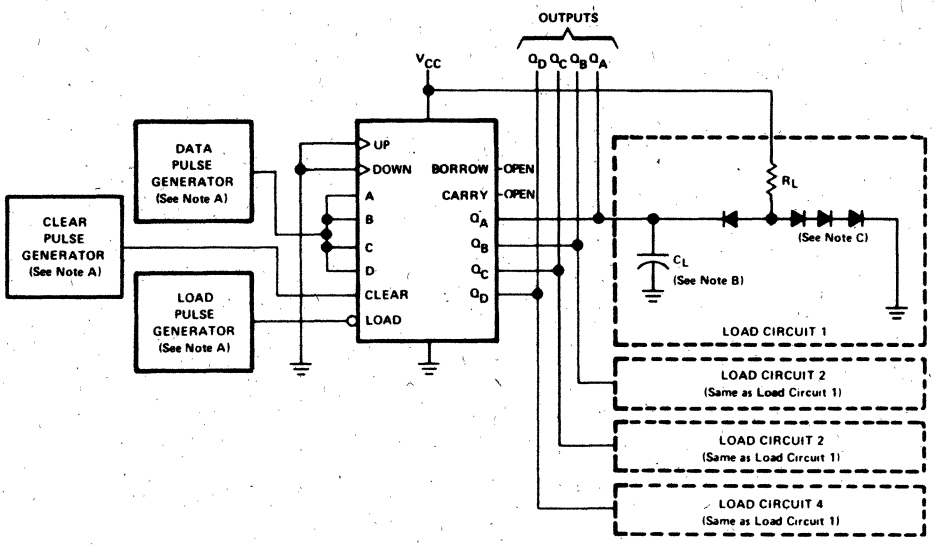
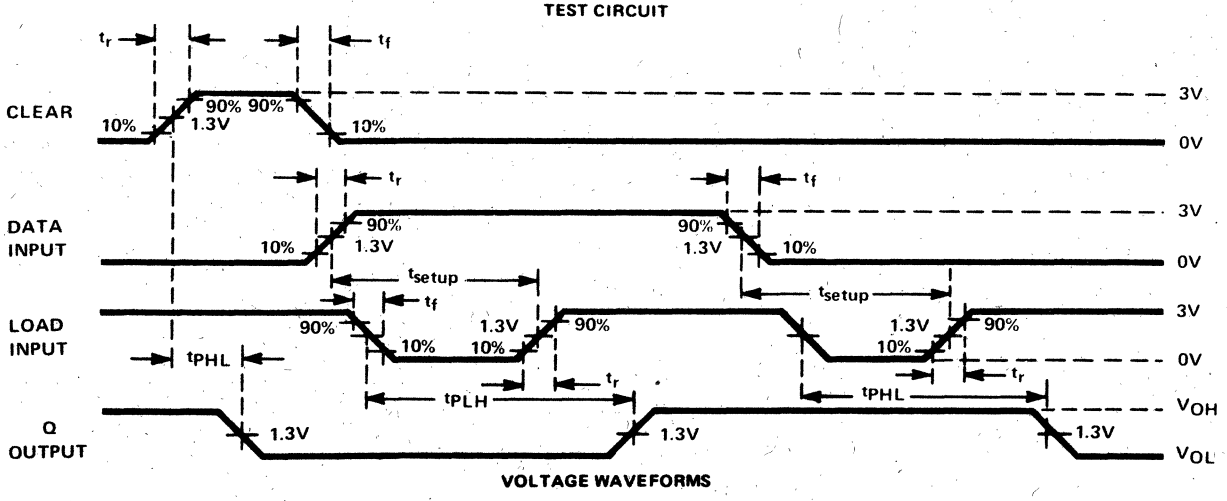
PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES:

A. The pulse generators have the following characteristics: $Z_{out} = 50\Omega$ and for the data pulse generator PRR < 500KHz, duty cycle = 50%; for the load pulse generator PRR is two times data PRR, duty cycle = 50%.
B. C_L includes probe and jig capacitance.
C. Diodes are 1N3064.
D. t_r and $t_f \leq 7$ ns.

FIGURE 1 — CLEAR, SETUP, AND LOAD TIMES

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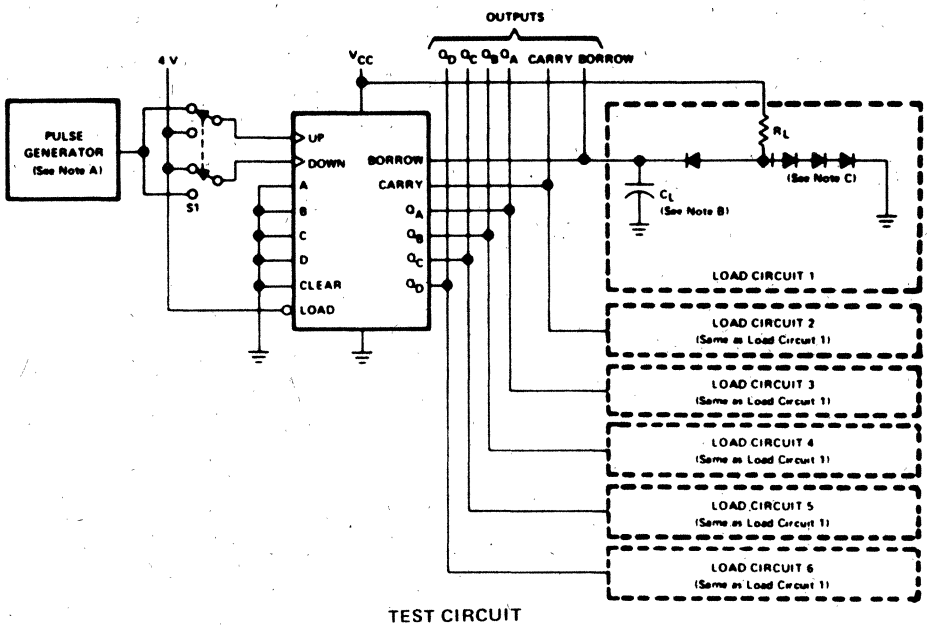
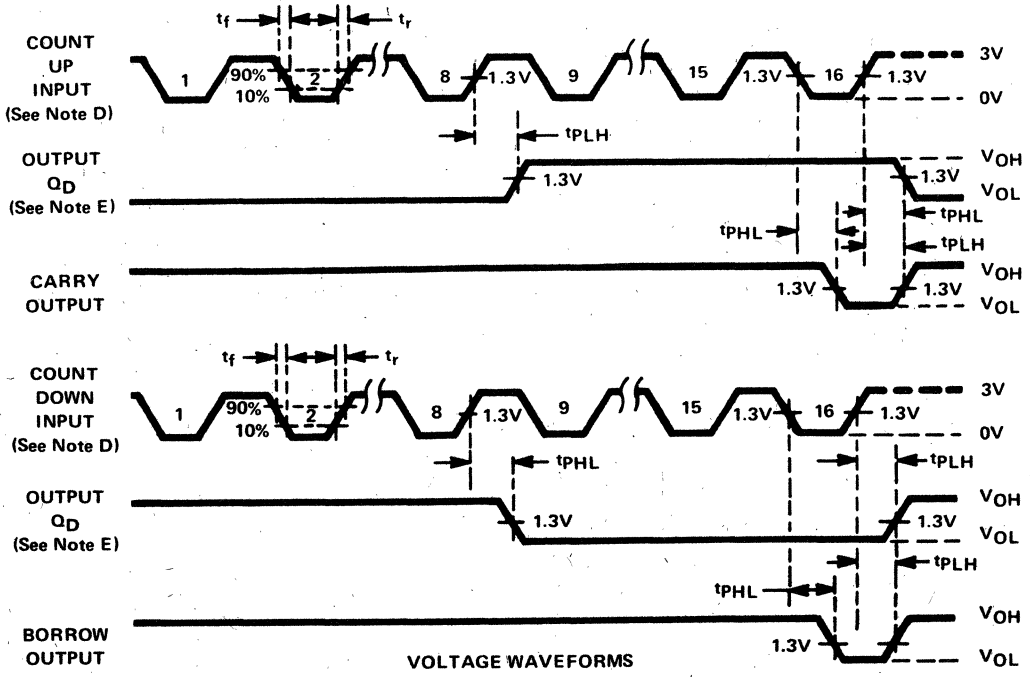
Synchronous BCD Decade Up/Down Counter — 25LS192
Synchronous 4-Bit Binary Up/Down Counter — 25LS193

PARAMETER MEASUREMENT INFORMATION (Continued)



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES:

A. The pulse generator has the following characteristics: PRR ≤ 1MHz, Z_{out} = 50Ω, duty cycle = 50%.
B. C_L includes probe and jig capacitance.
C. Diodes are 1N3064.
D. Count-up and count-down pulse shown is for the 25LS193 binary counter. Count cycle for 25LS192 decade counter is 1 through 10.
E. Waveforms for outputs Q_A, Q_B, and Q_C are omitted to simplify the drawing.
F. t_r and t_f ≤ 7ns.

FIGURE 2–PROPAGATION DELAY TIMES

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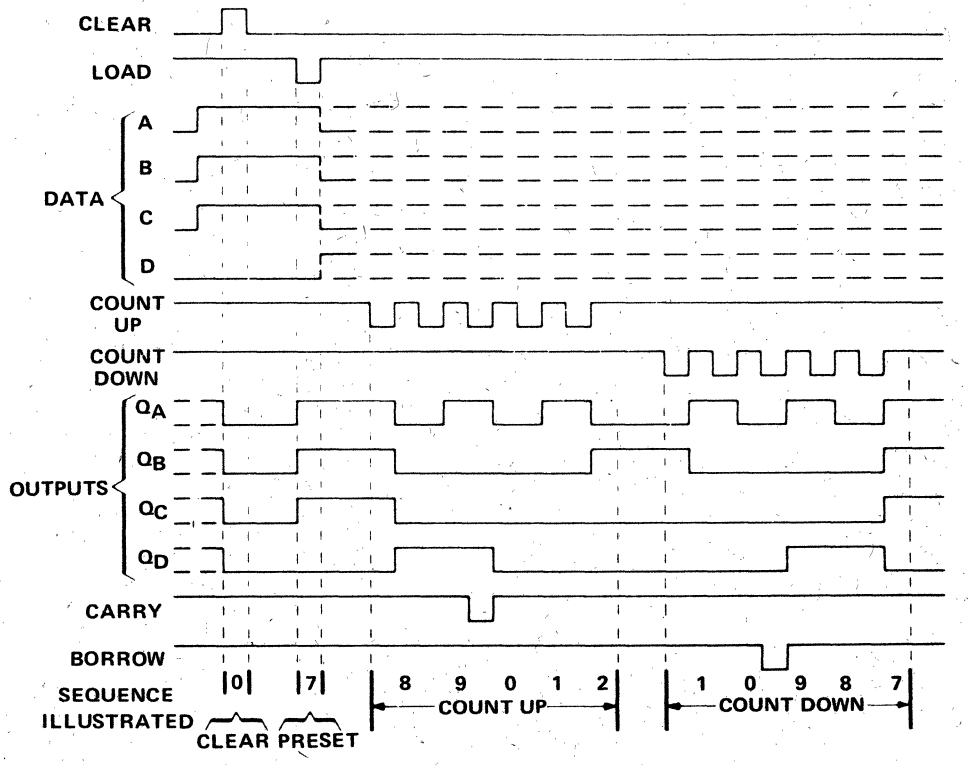
TYPICAL CLEAR, LOAD, AND COUNT SEQUENCES

25LS192

Illustrated below is the following sequence:

1. Clear outputs to zero.
2. Load (preset) to BCD seven.
3. Count up to eight, nine, carry, zero, one, and two.
4. Count down to one, zero, borrow, nine, eight, and seven.



NOTES:
A. Clear overrides load, data, and count inputs.
B. When counting up, count-down input must be high; when counting down, count-up input must be high.

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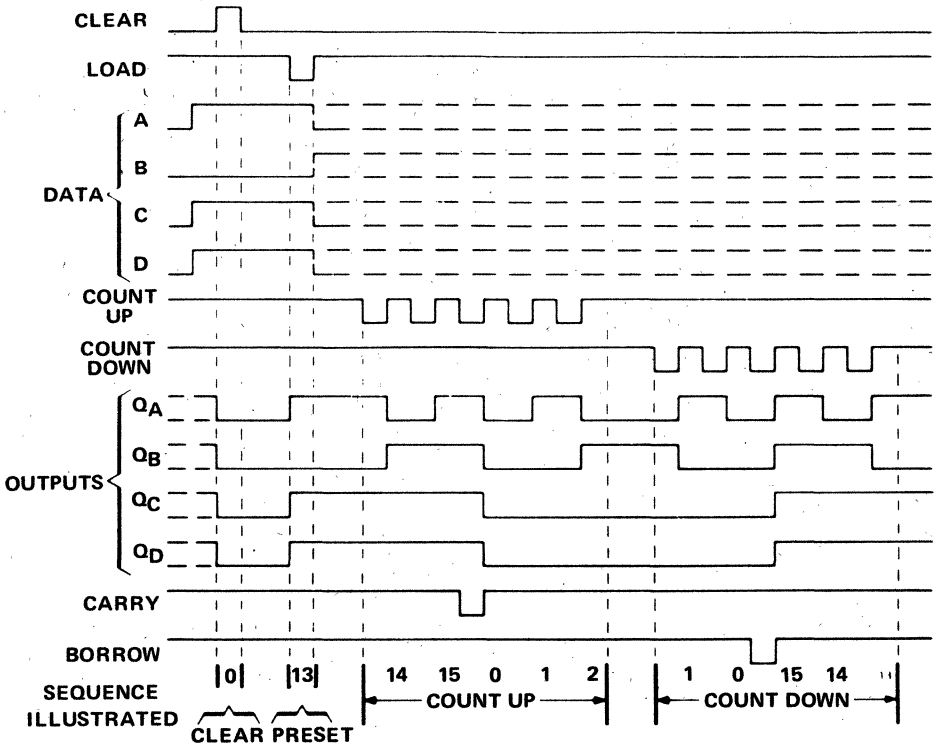
Synchronous BCD Decade Counter — 25LS192
Synchronous 4-Bit Binary Up/Down Counter — 25LS193

TYPICAL CLEAR, LOAD, AND COUNT SEQUENCES
25LS193

Illustrated below is the following sequence:

1. Clear outputs to zero.
2. Load (preset) to binary thirteen.
3. Count up to fourteen, fifteen, carry, zero, one, and two.
4. Count down to one, zero, borrow, fifteen, fourteen, and thirteen.



NOTES:
A. Clear overrides load, data, and count inputs.
B. When counting up, count-down input must be high; when counting down, count-up input must be high.

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FEATURES

- **Higher speed compared to 9LS/54LS and 9LS/74LS**
- **8mA sink current over full military temperature range**
- **50mV improved V_{OL} compared to 9LS/74LS**
- **440μA source current**
- **100% reliability assurance testing in compliance with MIL-STD-883.**

DESCRIPTION

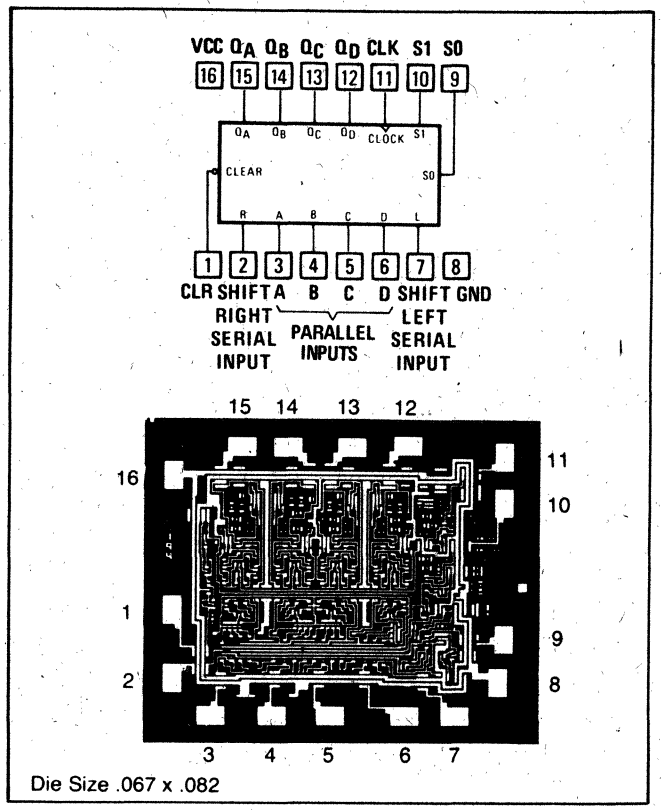
This bidirectional shift register is designed to incorporate virtually all of the features a system designer may want in a shift register. The circuit contains 46 equivalent gates and features parallel inputs, parallel outputs, right-shift and left-shift inputs, operating-mode-control inputs, and a direct over-riding clear line. The register has four distinct modes of operation, namely:

Parallel (broadside) load
Shift right (in the direction Q_A toward Q_D)
Shift left (in the direction Q_D toward Q_A)
Inhibit clock (do nothing)

Synchronous parallel loading is accomplished by applying the four bits of data and taking both mode control inputs, S0 and S1, high. The data are loaded into the associated flip-flops and appear at the outputs after the positive transition of the clock input. During loading, serial data flow is inhibited.

Shift right is accomplished synchronously with the rising edge of the clock pulse when S0 is high and S1 is low. Serial data for this mode is entered at the shift-right data input. When S0 is low and S1 is high, data shifts left synchronously and new data is entered at the shift-left serial input. Clocking of the flip-flop is inhibited when both mode control inputs are low.

PIN-OUT DIAGRAM



Die Size .067 x .082

FUNCTION TABLE

INPUTS										OUTPUTS			
CLEAR	MODE		CLOCK	SERIAL		PARALLEL				Q_A	Q_B	Q_C	Q_D
	S1	S0		LEFT	RIGHT	A	B	C	D				
L	X	X	X	X	X	X	X	X	X	L	L	L	L
H	X	X	L	X	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}
H	H	H	↑	X	X	a	b	c	d	a	b	c	d
H	L	H	↑	X	H	X	X	X	X	H	Q_{An}	Q_{Bn}	Q_{Cn}
H	L	H	↑	X	L	X	X	X	X	L	Q_{An}	Q_{Bn}	Q_{Cn}
H	H	L	↑	H	X	X	X	X	X	Q_{Bn}	Q_{Cn}	Q_{Dn}	H
H	H	L	↑	L	X	X	X	X	X	Q_{Bn}	Q_{Cn}	Q_{Dn}	L
H	L	L	X	X	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}

H = high level (steady state)
L = low level (steady state)
X = irrelevant (any input, including transitions)
↑ = transition from low to high level
a, b, c, d = the level of steady-state input at inputs A, B, C, or D, respectively.
Q_{A0}, Q_{B0}, Q_{C0}, $2Q_{D0}$ = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the indicated steady-state input conditions were established.
Q_{An}, Q_{Bn}, Q_{Cn}, Q_{Dn} = the level of Q_A, Q_B, Q_C, respectively, before the most-recent ↑ transition of the clock.

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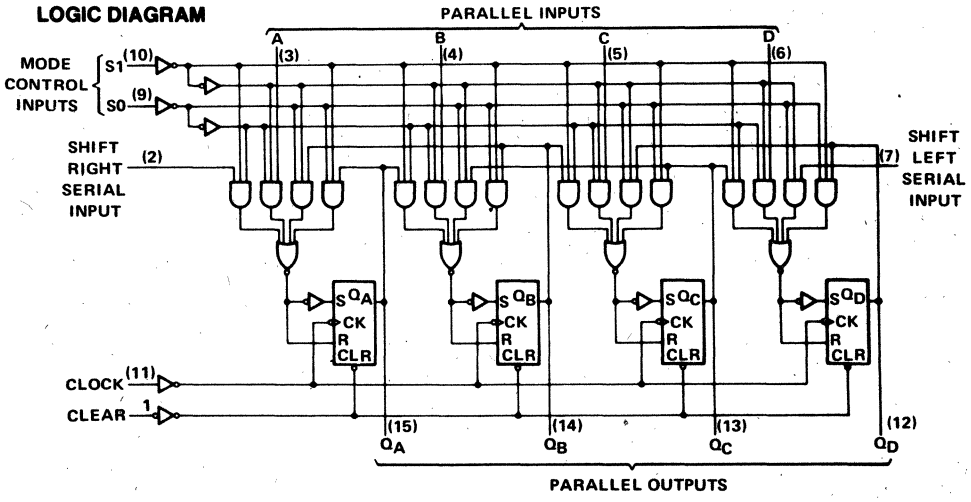
4-Bit Universal Shift Register

25LS194A

LOGIC DIAGRAM



Recommended Operating Conditions

		Military			Commercial			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}				-440			-440	μA
Low-level output current, I_{OL}				4			8	mA
Clock frequency, f_{clock}		0		35	0		35	MHz
Width of clock or clear pulse, t_w		20			20			ns
Setup time, t_{setup}	Mode control	30			30			ns
	Serial and parallel data	16			16			ns
	Clear inactive-state	18			18			ns
Hold time at any input, t_{hold}		0			0			ns
Operating free-air temperature, T_A		-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		Military			Commercial			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=--440μA		2.5	3.5		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.40		0.25	0.40	V
		I_{OL}=8mA		0.30	0.45		0.30	0.45	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.4			-0.36	mA
I_{OS}†	V_{CC}=MAX		-15		-85	-15		-85	mA
I_{CC}††	V_{CC}=MAX			15	23		12	23	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

††With all outputs open, inputs A through D grounded, and 4.5V applied to S0, S1, clear, and the serial inputs, I_{CC} is tested with a momentary GND, then 4.5V, applied to clock.

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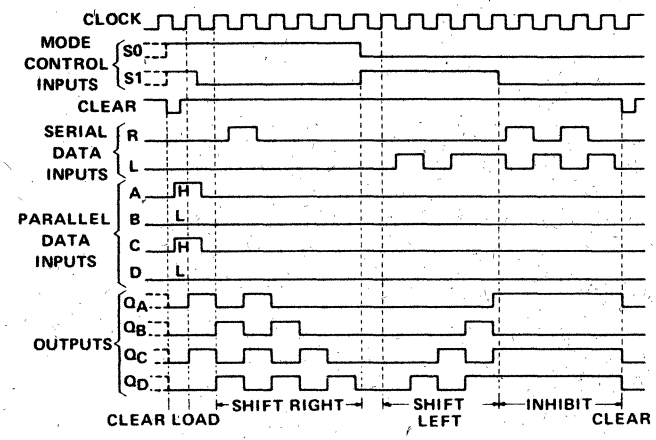
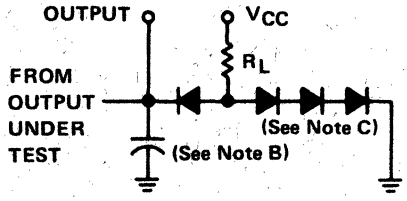
Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter	+25°C			Unit
	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ				
f_{max}	35	45		MHz
t_{PHL} Clock to Output		13	21	ns
t_{PLH} Clock to Output		12	18	ns
t_{PHL} Clear to Output		27	35	ns

TYPICAL TIMING SEQUENCES



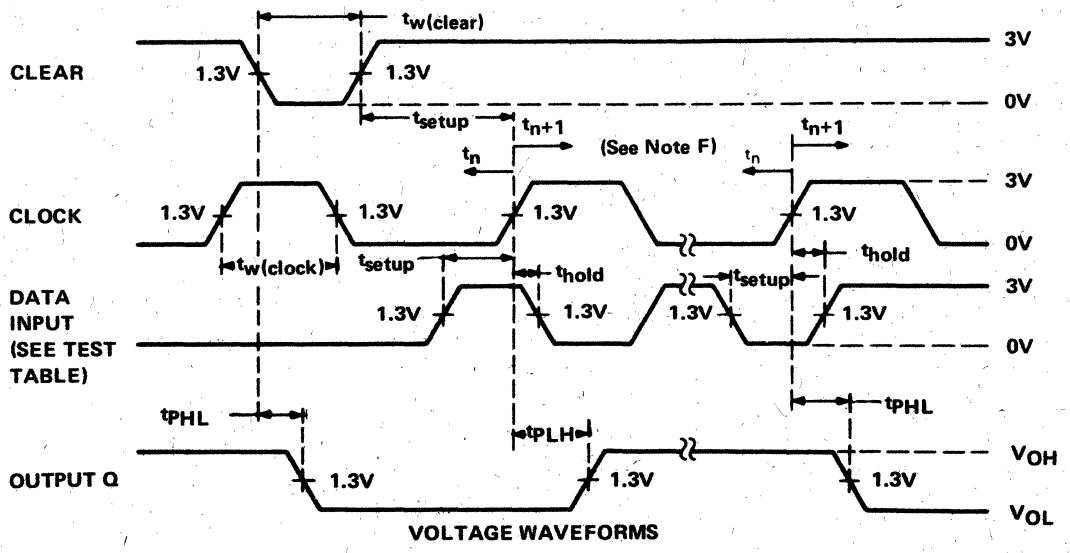
PARAMETER MEASUREMENT INFORMATION



LOAD FOR OUTPUT UNDER TEST

TEST TABLE FOR SYNCHRONOUS INPUTS

DATA INPUT FOR TEST	S1	S0	OUTPUT TESTED (SEE NOTE E)
A	4.5 V	4.5 V	Q_A at t_{n+1}
B	4.5 V	4.5 V	Q_B at t_{n+1}
C	4.5 V	4.5 V	Q_C at t_{n+1}
D	4.5 V	4.5 V	Q_D at t_{n+1}
L Serial Input	4.5 V	0 V	Q_A at t_{n+4}
R Serial Input	0 V	4.5 V	Q_D at t_{n+4}



VOLTAGE WAVEFORMS

NOTES:

A. The clock pulse generator has the following characteristics: $Z_{out} \approx 50\ \Omega$ and PRR ≤ 1 MHz, $t_r \leq 15$ns and $t_f \leq 6$ ns. When testing f_{max}, vary PRR.

B. C_L includes probe and jig capacitance.

C. All diodes are 1N3064 or 1N916.

D. A clear pulse is applied prior to each test.

E. V_{ref} = 1.3V.

F. Propagation delay times (t_{PLH} and t_{PHL}) are measured at t_{n+1}. Proper shifting of data is verified at t_{n+4} with a functional test.

G. t_n = bit time before clocking transition.
t_{n+1} = bit time after one clocking transition.
t_{n+4} = bit time after four clocking transitions.

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4-Bit Parallel-Access Shift Register

25LS195A

FEATURES

- **Higher speed compared to 9LS/54LS and 9LS/74LS**
- **8mA sink current over full military temperature range**
- **50mV improved V_{OL} compared to 9LS/74LS**
- **440μA source current**
- **100% reliability assurance testing in compliance with MIL-STD-883**

DESCRIPTION

This 4-bit register features parallel inputs, parallel outputs, J-$\overline{K}$ serial inputs, shift/load control input, and a direct overriding clear. All inputs are buffered to lower the input drive requirements. The register has two modes of operation:

Parallel (broadside) load

Shift (in the direction Q_A toward Q_D)

Parallel loading is accomplished by applying the four bits of data and taking the shift/load control input low. The data is loaded into the associated flip-flop and appears at the outputs after the positive transition of the clock input. During loading, serial data flow is inhibited.

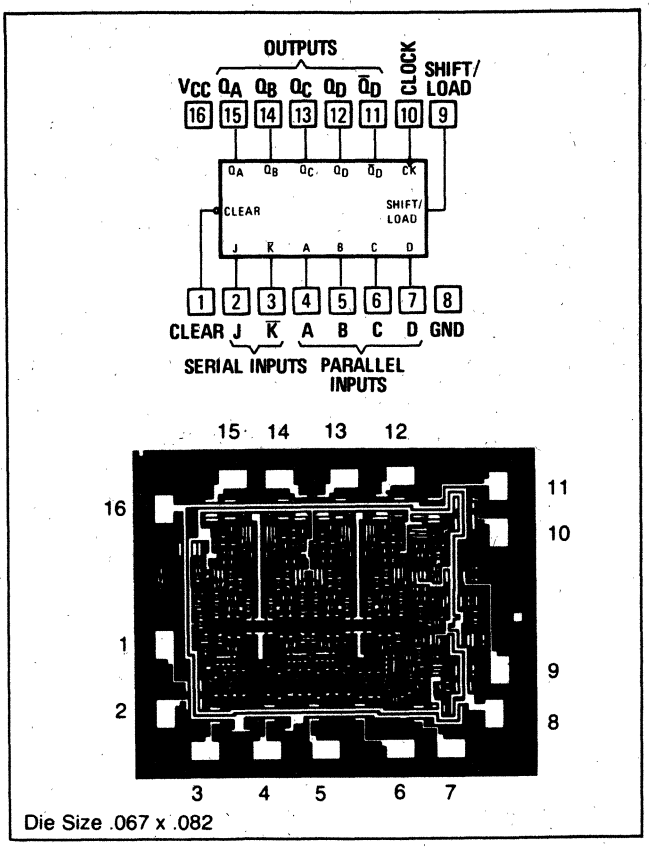
Shifting is accomplished synchronously when the shift/load control input is high. Serial data for this mode is entered at the J-$\overline{K}$ inputs. These inputs permit the first stage to perform as J-$\overline{K}$, D-, or T-type flip-flop as shown in the function table.

FUNCTION TABLE

INPUTS									OUTPUTS				
CLEAR	SHIFT/ LOAD	CLOCK	SERIAL		PARALLEL				Q_A	Q_B	Q_C	Q_D	$\overline{Q}_D$
			J	$\overline{K}$	A	B	C	D					
L	X	X	X	X	X	X	X	X	L	L	L	L	H
H	L	↑	X	X	a	b	c	d	a	b	c	d	$\overline{d}$
H	H	L	X	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}	$\overline{Q}_{D0}$
H	H	↑	L	H	X	X	X	X	Q_{A0}	Q_{A0}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$
H	H	↑	L	L	X	X	X	X	L	Q_{An}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$
H	H	↑	H	H	X	X	X	X	H	Q_{An}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$
H	H	↑	H	L	X	X	X	X	Q_{An}	Q_{An}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$

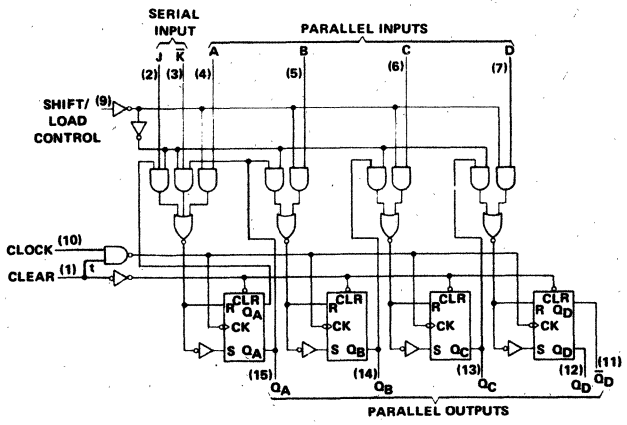
H = high level (steady state)
L = low level (steady state)
X = irrelevant (any input, including transitions)
↑ = transition from low to high level
a, b, c, d = the level of steady-state input at A, B, C, or D, respectively.
Q_{A0}, Q_{B0}, Q_{C0}, Q_{D0} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the indicated steady-state input conditions were established.
Q_{An}, Q_{Bn}, Q_{Cn} = the level of Q_A, Q_B, or Q_C, respectively, before the most-recent transition of the clock.

PIN-OUT DIAGRAM



Die Size .067 x .082

LOGIC DIAGRAM



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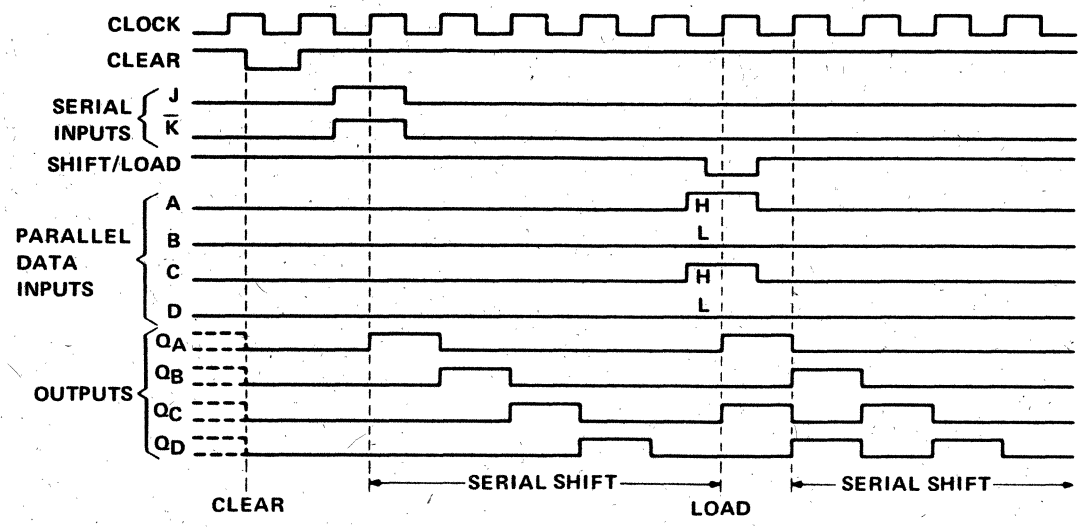
TYPICAL TIMING SEQUENCES



Recommended Operating Conditions

		Military			Commercial			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}				-440			-440	μA
Low-level output current, I_{OL}				4			8	mA
Clock frequency, f_{clock}		0		35	0		35	MHz
Width of clock pulse, $t_{w(clock)}$		18			18			ns
Width of clear input pulse, $t_{w(clear)}$		20			20			ns
Setup time, t_{setup} (see Figure 1)	Shift/load	25			25			ns
	Serial and parallel data	15			15			
	Clear inactive-state	20			25			
Shift/load release time, $t_{release}$ (see Figure 1)				0			0	ns
Serial and parallel data hold time, t_{hold} (see Figure 1)		0			0			ns
Operating free-air temperature, T_A		-55		125	0		70	°C

Switching Characteristics, V_{cc} = 5V Over Recommended Free-Air Temperature Range

Parameter	+25°C			Unit
	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. 1)				
f_{max}	35	45		MHz
t_{PHL} Clear to Output		27	35	ns
t_{PLH} Clock to Output		13	21	ns
t_{PHL} Clock to Output		15	22	ns

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4-Bit Parallel-Access Shift Register

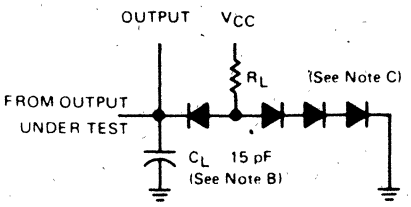
Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter	Test Conditions*		Military			Commercial			Unit
			Min	Typ**	Max	Min	Typ**	Max	
V_{IH}			2			2			V
V_{IL}					0.7			0.8	V
V_I	V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}= -440μA		2.5	3.4		2.7	3.4		V
V_{OL}	V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA		0.25	0.40		0.25	0.40	V
		I_{OL}=8mA					0.30	0.45	
I_I	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
I_{IH}	V_{CC}=MAX, V_I=2.7V				20			20	μA
I_{IL}	V_{CC}=MAX, V_I=0.4V				-0.4			-0.36	mA
I_{OS}†	V_{CC}=MAX		-15		-85	-15		-85	mA
I_{CC}††	V_{CC}=MAX			14	21		10	17	mA

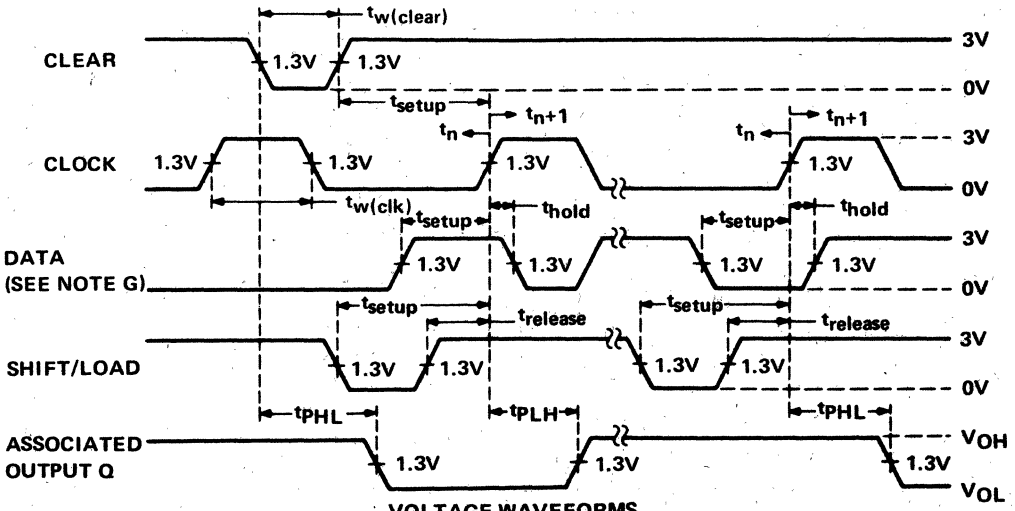
*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
**All typical values are at V_{CC} = 5V, T_A = 25°C.
†Not more than one output should be shorted at a time.
††With all outputs open, shift/load grounded and 4.5V applied to the J, $\overline{K}$, and data inputs, I_{CC} is measured by applying a momentary ground, followed by 4.5V, to clear and then applying a momentary ground, followed by 4.5V to clock.

PARAMETER MEASUREMENT INFORMATION

FIGURE 1



LOAD FOR OUTPUT UNDER TEST



VOLTAGE WAVEFORMS

NOTES:
A. The clock pulse generator has the following characteristics: Z_{out} ≈ 50 Ω and PRR ≤ MHz, t_r ≤ 15 ns, and t_f ≤ 6 ns. When testing f_{max}, vary the clock PRR.
B. C_L includes probe and jig capacitance.
C. All diodes are 1N3064.
D. A clear pulse is applied prior to each test.
E. Propagation delay times (t_{PLH} and t_{PHL}) are measured at t_{n+1}. Proper shifting of data is verified at t_{n+4} with a functional test.
F. J and $\overline{K}$ are tested the same as data A, B, C, and D inputs except that shift/load input remains high.
G. t_n = bit time before clocking transition.
t_{n+1} = bit time after one clocking transition.
t_{n+4} = bit time after four clocking transitions.

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Quadruple 2-Line-To-1-Line Multiplexers With Three-State Outputs

FEATURES

- Higher speed compared to 9LS/54LS and 9LS/74LS
- 8mA sink current over full military temperature range
- 50mV improved V_{OL} compared to 9LS/74LS
- 440μA source current
- 100% reliability assurance testing in compliance with MIL-STD-883.

DESCRIPTION

These data selectors/multiplexers select a 4-bit word from one of two sources and present it at the four outputs. The 25LS257 presents true data; the 25LS258 presents inverted data. With Output Control HIGH, the outputs are forced to a high impedance state.

FUNCTION TABLE

INPUTS				OUTPUT Y	
OUTPUT CONTROL	SELECT	A	B	LS257	LS258
H	X	X	X	Z	Z
L	L	L	X	L	H
L	L	H	X	H	L
L	H	X	L	L	H
L	H	X	H	H	L

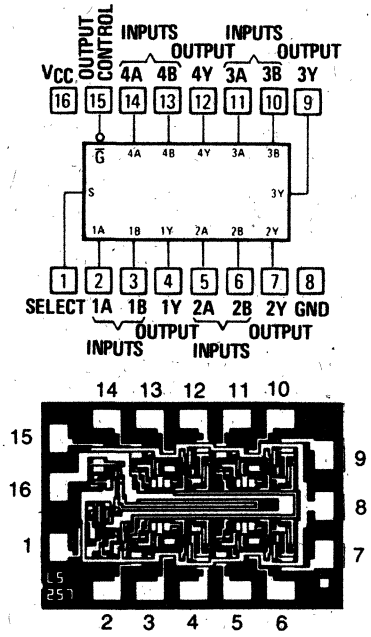
H = high level, L = low level, X = irrelevant, Z = high impedance (off)

Low level at S selects A inputs.

High level at S selects B inputs.

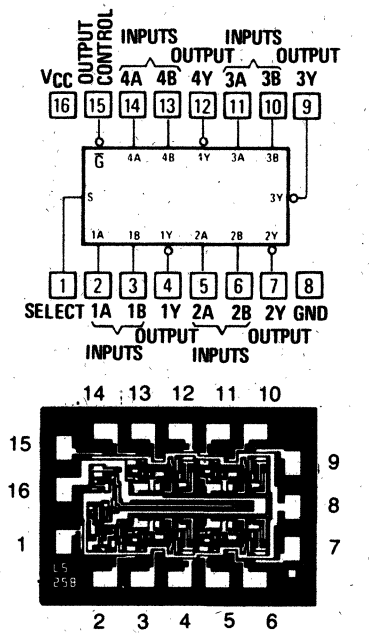
PIN-OUT DIAGRAMS

25LS257



Die Size .047 x .066

25LS258



Die Size .047 x .066

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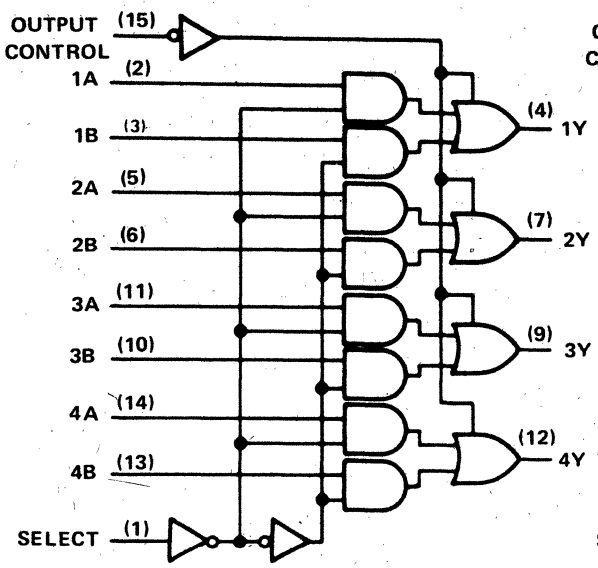
Quadruple 2-Line-To-1-Line Multiplexers With Three-State Outputs

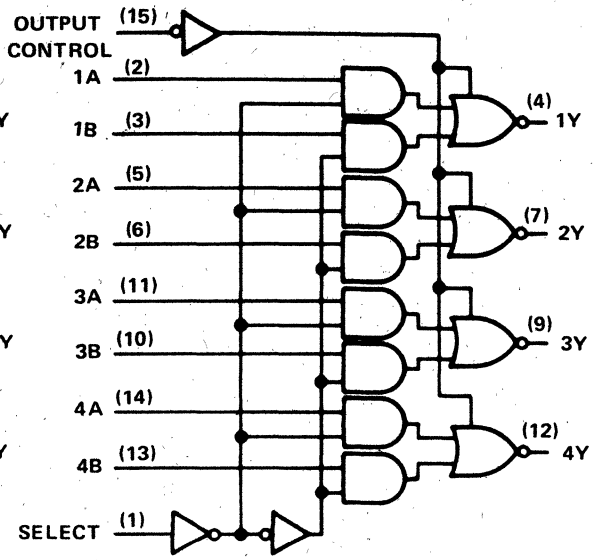
25LS257 25LS258

LOGIC DIAGRAMS

25LS257



25LS258



Recommended Operating Conditions

	Military			Commercial			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-1			-2.6	mA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

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Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		Military			Commercial			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL} max, I_{OH}=MAX		2.4	3.4		2.4	3.1		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL} max	I_{OL}=4mA		0.25	0.40		0.25	0.40	V
			I_{OL}=8mA		0.30	0.45		0.30	0.45	
I_{OZH}		V_{CC}=MAX, V_{IH}=2V V_O=2.4V				20			20	μA
I_{OZL}		V_{CC}=MAX, V_{IH}=2V, V_O=0.4V				-20			-20	μA
I_I	S input	V_{CC}=MAX, V_I=7V				0.2			0.2	mA
	Any other					0.1			0.1	
I_{IH}	S input	V_{CC}=MAX, V_I=2.7V				40			40	μA
	Any other					20			20	
I_{IL}	S input	V_{CC}=MAX, V_I=0.4V				-0.8			-0.8	mA
	Any other					-0.4			-0.4	
I_{OS}†		V_{CC}=MAX		-15		-85	-15	-15	-85	mA
I_{CC}††	All outputs high	V_{CC}=MAX	25LS257		5.9	10.0		5.9	10.0	mA
	All outputs low				8.2	13.5		9.2	13.5	
	All outputs off				10	15.3		10	15.3	
	All outputs high		25LS258		4.1	8.0		4.1	8.0	
	All outputs low				6.2	11.0		6.2	11.0	
	All outputs off				7.0	11.2		7.0	11.2	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

††I_{CC} is measured with all outputs open and all possible inputs grounded while achieving the stated output conditions.

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Quadruple 2-Line-To-1-Line Multiplexers With Three-State Outputs

Switching Characteristics, V_{CC} = 5V, T_A = 25°C

Parameter ¶		From (input)	To (output)	+25°C Min	+25°C Typ	+25°C Max	Unit
Test Conditions: C_L = 15pF, R_L = 2kΩ							
t_{PLH}	25LS257	Data	Any		6	12	ns
t_{PHL}					7	12	
t_{PLH}	25LS258	Data	Any		8	12	ns
t_{PHL}					5	12	
t_{PLH}	25LS257	Select	Any		12	18	ns
t_{PHL}					12	18	
t_{PLH}	25LS258	Select	Any		12	18	ns
t_{PHL}					10	18	
t_{ZH}	25LS257	Output Control	Any		10	18	ns
t_{ZL}					10	16	
t_{ZH}	25LS258	Output Control	Any		10	18	ns
t_{ZL}					11	18	
Test Conditions: C_L = 5pF, R_L = 2kΩ							
t_{HZ}	25LS257	Output Control	Any		10	15	ns
t_{LZ}					10	18	
t_{HZ}	25LS258	Output Control	Any		9	15	ns
t_{LZ}					8	15	

¶ t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
t_{ZH} = output enable time to high level
t_{ZL} = output enable time to low level
t_{HZ} = output disable time from high level
t_{LZ} = output disable time from low level

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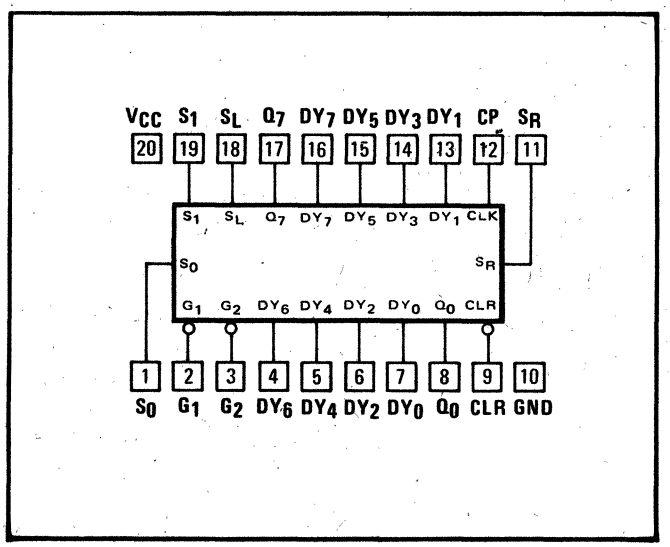
FEATURES

- Four operational modes
- Three-state outputs
- Common input/output pins
- Cascadable shifting
- Advanced Low-Power Schottky processing
- 100% reliability assurance testing in compliance with MIL-STD-883

PIN-OUT DIAGRAM



DESCRIPTION

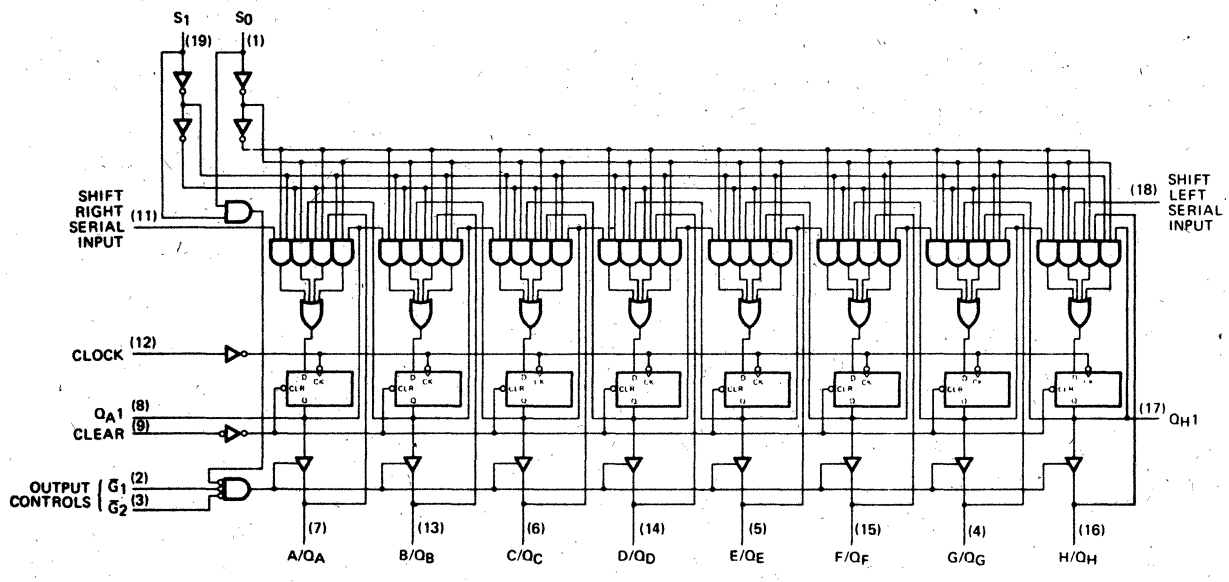
The 25LS299 is an 8-bit universal shift/storage register with 3-state outputs. Four modes of operation are possible—Hold (store), shift left, shift right and load data.

Parallel load inputs and register outputs are multiplexed to reduce the number of package pins. Separate continuous outputs are also provided for flip-flop Q_0 and Q_7. These devices can be cascaded to N-Bit words.

The 25LS299 has a typical shift frequency of 50 MHz; and is packaged in the standard 20-pin DIP package.

A separate active-LOW asynchronous clear input forces all flip-flops to the LOW state whenever this clear input is LOW.

LOGIC DIAGRAM



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8-Bit Universal Shift/Storage Register

25LS299

Recommended Operating Conditions

	Military			Commercial			Unit
	Min	Nom	Max	Min	Nom	Max	
Supply Voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-Level Output Current, I_{OH}			-1.0			-2.6	mA
Low-Level Output Current, I_{OL}			8			8	mA
Operating Free-Air Temperature, T_A	-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		Military			Comercial			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}		Guaranteed input logical HIGH voltage for all inputs		2			2			V
V_{IL}		Guaranteed input logical LOW voltage for all inputs				0.7			0.8	V
V_I		V_{CC}=MIN., I_{IN} = -18mA				-1.5			-1.5	V
V_{OH}		V_{CC}=MIN., I_{OH}= -440μA, V_{IN} =V_{IH} or V_{OL},	Q_0, Q_7	2.5			2.7			V
			DY_0, DY_7	2.4			2.4			
V_{OL}		V_{CC} =MIN., V_{IN} =V_{IH} or V_{IL}	I_{OL} = 4.0mA		0.25	0.40		0.25	0.40	V
			I_{OL} = 8.0mA		0.30	0.45		0.30	0.45	
I_I	S_0, S_1	V_{CC} =MAX., V_{IN} = 5.5V				0.2			0.2	mA
	All others					0.1			0.1	
I_H	S_0, S_1	V_{CC} =MAX., V_{IN} = 2.7V				40			40	μA
	All others					20			20	
I_{IL}	S_0, S_1	V_{CC}=MAX., V_{IN} = 0.4V				-0.8			-0.8	mA
	All others					-0.4			-0.4	
I_O		V_{CC} =MAX.	V_0 = 0.4V			-100			-100	μA
			V_0 = 2.7V			40			40	
I_{OS}		V_{CC} =MAX., See Note 3		-30		-85	-30		-85	mA
I_{CC}		V_{CC} =MAX., See Note 4			38	57		38	57	mA

Notes: 1. For conditions shown as MIN. or MAX., use the appropriate value specified under Electrical Characteristics for the applicable device type.

2. Typical limits are at V_{CC} = 5.0 V, 25°C ambient and maximum loading.

3. Not more than one output should be shorted at a time. Duration of the short circuit test should not exceed one second.

4. I_{CC} – measured with clock input HIGH and output controls HIGH.

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Switching Characteristics, V_{CC} = 5V, T_A = +25°C

Parameter	From (Input)	To (output)	+25°C Min	+25°C Typ	+25°C Max	Unit
Test Conditions: C_L = 15pF, R_L = 2kΩ						
t_{PLH}	Clock	Q_i		19		ns
t_{PHL}				23		
t_{PLH}	Clock	DY_i		18		ns
t_{PHL}				21		
t_{PHL}	Clear	DY_0-DY_7		25		ns
t_{PHL}	Clear	Q_0 or Q_7		27		ns
t_{ZH}	S_1, S_0	DY_i		20		ns
t_{ZL}				19		
t_{ZH}	$\overline{G}_1$, $\overline{G}_2$	DY_i		20		ns
t_{ZL}				18		
t_s	S_1, S_0 Set-up Prior to Clock		20			ns
t_s	S_R, S_L Set-up Prior to Clock		20			ns
t_{pw}	Pulse Width (Clock)		25			ns
t_n	Hold Time		3			ns
f_{max}				50		MHz
t_{LZ}	S_1, S_0	DY_i		22		ns
t_{HZ}				20		
t_{LZ}	$\overline{G}_1$, $\overline{G}_2$	DY_i		20		ns
t_{HZ}				16		

TRUTH TABLE

FUNCTION		INPUTS S_R	S_L	CLEAR	CLOCK	S_0	S_1	$\overline{G}_1$ $\overline{G}_2$	OUTPUTS Q_0	Q_7	INPUTS/OUTPUTS DY_0	DY_1	DY_2	DY_3	DY_4	DY_5	DY_6	DY_7
Clear		X	X	L	X	(Note 1)		L L	L	L	L	L	L	L	L	L	L	L
Output Control		X	X	X	X	X	X	H L	NC	NC	Z	Z	Z	Z	Z	Z	Z	Z
		X	X	X	X	X	X	L H	NC	NC	Z	Z	Z	Z	Z	Z	Z	Z
		X	X	X	X	X	X	H H	NC	NC	Z	Z	Z	Z	Z	Z	Z	Z
MODE	Hold	X	X	H	X	L	L	L L	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
	Load (Note 2)	X	X	H	↑	H	H	L L	A	A	A	B	C	D	E	F	G	H
	Shift Right	L	X	H	↑	H	L	L L	L	DY_6	L	DY_0	DY_1	DY_2	DY_3	DY_4	DY_5	DY_6
	Shift Right	H	X	H	↑	H	L	L L	H	DY_6	H	DY_0	DY_1	DY_2	DY_3	DY_4	DY_5	DY_6
	Shift Left	X	L	H	↑	L	H	L L	DY_1	L	DY_1	DY_2	DY_3	DY_4	DY_5	DY_6	DY_7	L
	Shift Left	X	H	H	↑	L	H	L L	DY_1	H	DY_1	DY_2	DY_3	DY_4	DY_5	DY_6	DY_7	H

L = LOW Z = High Impedence ↑ = Transition LOW-to-HIGH
H = HIGH X = Don't Care NC = No Change

Notes: 1. Either LOW to observe outputs.
2. In this mode DY_i are inputs.

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INTRODUCTION TO INTERFACE

INTERFACE.....

The Master Selection Guide provides sufficient information to make initial product selections, to lead you to a group of device numbers and manufacturers' names. It enables you to find the products which are most appropriate to fulfill your major requirements and then provides data for many of the more important products.

All devices that appear in this section, both in the initial selection guide and in the data pages, are included in the Part Number and Product Indexes. These index listings lead to the page and the line on that page where each device appears.

In the Interface Section the selection parameters differ drastically for each category; therefore, each has its own format. The analog to digital converter category has two formats: one for binary output devices and another for decimal units. Some of the products in this section, primarily analog to digital and digital to analog converters, are hybrids; the ones listed are those packaged to be compatible with IC's.

This section is not complicated by reference to package styles; the package style suffixes are usually deleted. For more information on each companies' suffixes, see the Part Number Guide. Throughout the Master Selection Guide, each full military temperature range (−55°C to 125°C) device is indicated by a dagger (†) before the manufacturer's name. Manufacturers' names are normally spelled out; however, a few are abbreviated and the abbreviations are explained on page 144.

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The manufacturers listed above are providing detailed information on their latest and most significant products. They have made this investment to help you. Some chose not to.

If you want to see more data in future editions, tell the manufacturers through their salesmen and distributors.

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INTERFACE—Analog Switches

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches with Drivers						
SPST	CMOS	75	±11	±15,5	1109	DDC
					HI5040-2	† Harris (433)
					HI5040-5	Harris (433)
					IH5040C	Intersil
					IH5040M	† Intersil
	JFET	6	-5 to 4	±15,5	CAG10A	† Teledyne C
			-5 to 10	±15	CAG6	† Teledyne C
		10	-5 to 4	±15,5	CAG10C	† Teledyne C
			-5 to 10	±15	CAG6-10	† Teledyne C
		15	-10 to 5	±15,5	CAG10D	† Teledyne C
		30	±5	±5,5	CAG10	† Teledyne C
			±8	-18,12	IH5001	Intersil
		50	±8	-18,12	IH5002	Intersil
			-10 to 4	±15,5	CAG10B	† Teledyne C
			-10 to 5	-15,5	CAG14	Teledyne C
		60	±10	±18,5	CAG30	† Teledyne C
	PMOS	40-100	±10	-20,10,5	DG171A	† Siliconix
		40-125	±10	-20,10,5	DG171B	Siliconix
		80-300	±10	-20,10	TL610I	TI
					TL610M	† TI
		100-400	±10	-20,10	TL610C	TI
2xSPST	CMOS	30	±11	±15,5	IH5048C	Intersil
					IH5048M	† Intersil
		50	±15	±15,5	HI5048-2	† Harris (433)
					HI5048-5	Harris (433)
				±15	DG300A	† Siliconix
					DG300B	Siliconix
					DG300C	Siliconix
					DG304A	† Siliconix
					DG304B	Siliconix
					DG304C	Siliconix
					DG381A	† Siliconix (509)
					DG381B	† Siliconix (509)
					DG381C	† Siliconix (509)
		70	±11	±15	DG200A	† Intersil
			±15	±15	AD7513S	† AD (430)
					HI200-2	† Harris (433)
					DG200A	† Siliconix
		75	±15	±15,5	1110	DDC
					HI5041-2	† Harris (433)
					HI5041-5	Harris (433)
					IH5041C	Intersil
					IH5041M	† Intersil
		80	±11	±15	DG200B	Intersil
			±15	±15	AD7513J	AD (430)
					AD7513K	AD (430)
					HI200-5	Harris (433)
					DG200B	Siliconix
					DG200C	Siliconix
	JFET	6	-6 to 10	-18,15	CAG27	† Teledyne C
		10	-6 to 10	-18,15	CAG27-10	† Teledyne C
			-7.5 to 15	±15,5	DG180A	† Siliconix
				(Cont'd)		

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches with Drivers (Cont'd)						
2xSPST	JFET	10	-7.5 to 15	(Cont'd)	DG180B	Siliconix
			±10	-18,12	DG141A	† Intersil
					IH5005	† Intersil
					AM0141	† National
					AM0141C	National
					DG141A	† Siliconix
				-20,10,5	DG180A	† Siliconix
					DG180B	Siliconix
		15	±7.5	±15	DG151A	† Intersil
					AM0151	† National
					AM0151C	National
					DG151A	† Siliconix
			±8	-18,12	DG141B	Intersil
					DG441	Intersil
					DG141B	Siliconix
		20	±5.5	±15	DG151B	Intersil
					DG451A	Intersil
					DG151B	Siliconix
		30	-6 to 10	-18,15	CAG24	† Teledyne C
			-7.5 to 15	±15,5	DG181A	† Intersil
					IH181M	† Intersil
					DG181A	† Siliconix
			±10	-18,12	DG133A	† Intersil
					IH5003	† Intersil
					IH5006	† Intersil
					AM0133	† National
					AM0133C	National
					DG133A	† Siliconix
			-12.5 to 10	-20,10,-5	DG181A	† Intersil
					IH181M	† Intersil
					DG181A	† Siliconix
			for D/A ±10	-20	CDA2-3	† Teledyne C
		35	±8	-18,12	DG433A	† Intersil
		50	±7.5	±15	DG152A	† Intersil
					AM0152	† National
					AM0152C	National
					DG152A	† Siliconix
			-7.5 to 15	±15,5	DG181B	Intersil
					IH181C	Intersil
					DG181B	Siliconix
			±8	-18,12	DG133B	Intersil
					DG133B	Siliconix
			±10	-18,15	CAG13	† Teledyne C
					CAG42	† Teledyne C
					CAG45A	† Teledyne C
				-18,12	IH5004	Intersil
			-12.5 to 10	-20,10,-5	DG181B	Intersil
					IH181C	Intersil
					DG181B	Siliconix
		75	±10	±15	TL182M	† TI
			-10 to 15	±15,5	DG182A	† Intersil
					IH182M	† Intersil
					DG182A	† Siliconix
				(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

DT¹ means four terminals with a pair of normally open and normally closed contacts.

INTERFACE—Analog Switches (Cont'd)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches with Drivers (Cont'd)						
2xSPST	JFET	75		(Cont'd)		
			-15 to 10	-20,10,-5	DG182A	† Intersil
					IH182M	† Intersil
					DG182A	† Siliconix
		80	±8	-18,12	DG434A	Intersil
			±10	-18,12	DG134A	† Intersil
					IH5007	Intersil
					AH0134	† National
					AH0134C	National
					DG134A	† Siliconix
		100	±5.5	±15	DG452	Intersil
					DG152B	Siliconix
			±8	-18,12	DG134B	Intersil
					DG134B	Siliconix
			±10	±15,5	TL182I	TI
					TL182C	TI
			-10 to 15	±15,5	DG182B	Intersil
					IH182C	Intersil
					DG182B	Siliconix
			-15 to 10	-20,10,-5	DG182B	Intersil
					IH182C	Intersil
					DG182B	Siliconix
	PMOS	75-200	-5 to 10	±15,5	DGM111A	† Siliconix
			±10	-20,10,5	DGM111A	† Siliconix
		75-250	-5 to 10	±15	DGM111B	Siliconix
			±10	-20,10,5	DGM111B	Siliconix
		100-450	±10	-20,10,5	DG111	† Intersil
					DG112	† Intersil
4xSPST	CMOS	80	±15	±15	**HI201-2**	**† Harris** (433)
		80*	±5	±5	CDS4016	† RCA
					CDS4016E	RCA
		100	±15	±15	**HI201-5**	**Harris** (433)
					AD7510J	**AD** (428)
					AD7510K	**AD** (428)
					AD7510S	**† AD** (428)
					AD7510DIJ	**AD** (428)
					AD7510DIK	**AD** (428)
					AD7510DIS	**† AD** (428)
					AD7511J	**AD** (428)
					AD7511K	**AD** (428)
					AD7511S	**† AD** (428)
					AD7511DIJ	**AD** (428)
					AD7511DIK	**AD** (428)
					AD7511DIS	**† AD** (428)
		175	±15	±15	DG201A	† Siliconix
		200	±7.5	±7.5	SCL4066S	SSS
			±15	±15	DG201B	Siliconix
					DG201C	Siliconix
		280	±7.5	±7.5	**AD7516K**	**AD** (430)
					AD7516T	**† AD** (430)
					F4066BC	Fairchild
					F4066BM	† Fairchild
					HD4066B-2	† Harris
					HD4066B-9	Harris
				(Cont'd)		

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches with Drivers (Cont'd)						
4xSPST	CMOS	280	±7.5	(Cont'd)		
					CD4066C	National
					CD4066M	† National
					SIL4066B	† Mitel
					SIL4066BE	Mitel
					MC14066BA	† Motorola
					MC14066BC	Motorola
					CD4066B	† RCA
					CD4066BE	RCA
					HBF4066AE	SGS
					N4066A	Signetics
					SCL4066B	† SSS
					SCL4066BE	SSS
					TC4066	Toshiba
		400	±7.5	±7.5	**AD7516J**	**AD** (430)
					AD7516S	**† AD** (430)
					SIL4016B	† Mitel
					SIL4016BE	Mitel
					MC14016BA	† Motorola
					MC14016BC	Motorola
					SCL4016B	† SSS
					SCL4016BE	SSS
					CM4016A	† Solitron
					CM4016AE	Solitron
					TP4016A	† TI
					TP4316A/4B	† TI
					TC4016	Toshiba
		800	±7.5	±7.5	F4016C	Fairchild
					F4016M	† Fairchild
		850	±7.5	±7.5	MEM4016D	† GI
					MEM4016P	GI
					CD4016AC	National
					CD4016AM	† National
					CD4016B	† RCA
					CD4016BE	RCA
					SCL4016A	† SSS
					SCL4016AE	SSS
					CM4016A	† Solitron
					CM4016AE	Solitron
					CM4116A	† Solitron
					CM4116AE	Solitron
					SW4016AE	SW
			Inverted control			
				±7.5	SCL4416A	† SSS
					SCL4416AE	SSS
	JFET	10	±10	-18,2.8	CAM604A	† Teledyne C
		50	-10 to 5	-15,5	CAG49	† Teledyne C
		60	±10	-18,5	CAG49	† Teledyne C
				±18,-7	CAG50	† Teledyne C
4xSPST Various Combinations of normally on/off	JFET	100	±10	-18,15	CAG48A	† Teledyne C
		200	±10	±15,0	LF11201	† National
					LF11202	† National
					LF11331	† National
					LF11332	† National
					LF11333	† National
		250 ± 10		±15,0	LF12201	National
					LF13201	National
				(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

INTERFACE—Analog Switches (Cont'd)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches with Drivers (Cont'd)						
4xSPST	JFET	250	±10	(Cont'd)		
					LF12202	National
					LF13202	National
					LF12331	National
					LF13331	National
					LF12332	National
					LF13332	National
					LF12333	National
					LF13333	National
	PMOS	100-450	±10	-20,10,5	DG118	† Intersil
		150-450	±10	-20,10,5	DG172A	† Siliconix
		150-500	±10	-20,10,5	DG172B	Siliconix
		200-600	±10	-20,10,5	AH0015	† National
					AH0015C	National
					DG172C	Siliconix
4xSPST Common Output	PMOS	100-450	±10	-20,10	DG116	† Intersil
					DG116A	† Siliconix
		125-500	±10	-20,10	DG116B	Siliconix
5xSPST Common Output	PMOS	100-450	±10	-20,10	DG123	† Intersil
					DG123A	† Siliconix
				-20,10,5	DG125	† Intersil
					DG125A	† Siliconix
				-20,10	DG123B	Intersil
					DG123B	Siliconix
				-20,10,5	DG125B	Intersil
					DG125B	Siliconix
SPDT[1]	CMOS	30	±11	±15,5	IH5050C	Intersil
					IH5050M	† Intersil
		50	±15	±15,5	**HI5050-2**	**† Harris (433)**
					HI5050-5	**Harris (433)**
				±15	DG301A	† Siliconix
					DG301B	Siliconix
					DG301C	Siliconix
					DG305A	† Siliconix
					DG305B	Siliconix
					DG305C	Siliconix
					DG387A	**† Siliconix (509)**
					DG387B	**Siliconix (509)**
					DG387C	**Siliconix (509)**
		75	±15	±15,5	1111	† DDC
					HI5042-2	**† Harris (433)**
					HI5042-5	**Harris (433)**
					IH5042C	Intersil
					IH5042M	† Intersil
	JFET	6	-5 to 10	±15	CAG7	† Teledyne C
		10	±10	-15,5	CDA23	† Teledyne C
			-5 to 10	±15	CAG7-10	† Teledyne C
			-7.5 to 15	±15,5	DG186A	† Siliconix
					DG186B	Siliconix
			±10	-18,12	DG146A	† Intersil
					AH0146	† National
					AH0146C	National
					DG146A	Siliconix
			-12.5 to 10	-20,10,-5 (Cont'd)	DG186A	† Siliconix

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches with Drivers (Cont'd)						
SPDT[1]	JFET	10	-12.5 to 10	(Cont'd)		
					DG186B	Siliconix
		15	±7.5	±15	DG161A	† Intersil
					AH0161	† National
					AH0161C	National
					DG161A	Siliconix
			±8	-18,12	DG146B	Intersil
					DG446A	Intersil
					DG146B	Siliconix
		20	±5.5	±15	DG461A	Intersil
					DG161B	Siliconix
		30	-7.5 to 15	±15,5	DG187A	† Intersil
					IH187M	† Intersil
					DG187A	† Siliconix
			±10	-18,12	DG144A	† Intersil
					AH0144	† National
					AH0144C	National
					DG144A	† Siliconix
			-12.5 to 10	-20,10,-5	DG187A	† Intersil
					IH187M	† Intersil
					DG187A	† Siliconix
		35	±8	±8,12	DG444A	Intersil
		50	±7.5	±15	DG162A	† Intersil
					AH0162	† National
					AH0162C	National
					DG162A	† Siliconix
			-7.5 to 15	±5,5	DG187B	Intersil
					IH187C	Intersil
					DG187B	Siliconix
			±8	-18,12	DG144B	Intersil
					DG144B	Siliconix
				±15	2126B	† Teledyne C
			-12.5 to 10	-20,10,5	DG187B	Intersil
					IH187C	Intersil
					DG187B	Siliconix
		75	±10	±15,5	TL188M	† TI
			-10 to 15	±15,5	DG188A	† Intersil
					IH188M	† Intersil
					DG188A	† Siliconix
			-15 to 10	-20,10,5	DG188A	† Intersil
					IH188M	† Intersil
					DG188A	† Siliconix
		80	±8	-18,12	DG443	Intersil
			±10	-18,12	DG143	† Intersil
					AH0143	† National
					AH0143C	National
					DG143A	† Siliconix
		100	±5.5	±15	DG162B	Siliconix
			±8	±15	DG462A	Intersil
			±10	±15,5	TL188I	TI
					TL188C	TI
				±15	AH2114	† National
				-18,12	DG143B	Siliconix
			-10 to 15	±15,5 (Cont'd)	DG188B	Intersil

† Military Temperature Range (−55°C to 125°C)

DT[1] means four terminals with a pair of normally open and normally closed contacts.

INTERFACE—Analog Switches (Cont'd)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches with Drivers (Cont'd)						
SPDT[1]	JFET	100	-10 to 15	(Cont'd)		
					IH188C	Intersil
					DG188B	Siliconix
			-15 to 10	-20,10,-5	DG188B	Intersil
					IH188C	Intersil
					DG188B	Siliconix
		125	±10	±15	AH2114C	National
SPDT	JFET	10	±10	-15,5	CDA23	† Teledyne C
		50	-10 to 5	-15,5	CDA18	† Teledyne C
SPDT for D/A	NPN-PNP	10	10	10	CDA4A	† Teledyne C
			-0 to -10	-15	CDA1-3	Teledyne C
			±10	±15	CDA6	† Teledyne C
SPDT[1]	PMOS	75-200	-5 to 15	±15	DG175A	† Siliconix
			±10	-20,10,5	DG175A	† Siliconix
		75-250	-5 to 15	±15	DG175B	Siliconix
			±10	-20,10,5	DG175B	Siliconix
		100-400	±10	-20,10	TL604I	TI
					TL604M	† TI
		200-600	±10	-20,10	TL604C	TI
SPDT	PMOS	100-400	±10	-20,10	SI3002A	† Siliconix
					SI3002B	Siliconix
					TL601I	TI
					TL601M	† TI
					TL607I	TI
					TL607M	† TI
				-20,10	TL601C	TI
					TL607C	TI
		200*	±10	-20,10	SH3002C	Fairchild
					SH3002M	† Fairchild
2xSPDT[1]	CMOS	30	±11	±15,5	IH5051C	Intersil
					IH5051M	† Intersil
		50	±15	±15,5	**HI5051-2**	**† Harris (433)**
					HI5051-5	**Harris (433)**
				±15	DG303A	† Siliconix
					DG303B	Siliconix
					DG303C	Siliconix
					DG307A	† Siliconix
					DG307B	Siliconix
					DG307C	Siliconix
					DG390A	**† Siliconix (509)**
					DG390B	**Siliconix (509)**
					DG390C	**Siliconix (509)**
		75	±15	±15,5	1112	† DDC
					HI5043-2	**† Harris (433)**
					HI5043-5	**Harris (433)**
					IH5043C	Intersil
					IH5043M	† Intersil
2xSPDT	CMOS	100	±15	±15	**AD7512J**	**AD (428)**
					AD7512K	**AD (428)**
					AD7512S	**† AD (428)**
					AD7512DIJ	**AD (428)**
					AD7512DIK	**AD (428)**
					AD7512DIS	**† AD (428)**
		10	±10	±15 (Cont'd)	CDA29A	† Teledyne C

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches with Drivers (Cont'd)						
2xSPDT			±10	(Cont'd)		
2xSPDT[1]	JFET	10	-7.5 to 15	±15,5	DG189A	† Siliconix
					DG189B	Siliconix
			±12.5 to 1	5 -20,15,-5	DG189A	† Siliconix
					DG189B	Siliconix
		30	-7.5 to 15	±15,5	DG190A	† Intersil
					IH190M	† Intersil
					DG190A	† Siliconix
			-12 to 15	-20,15,-5	DG190A	† Intersil
					IH190M	† Intersil
					DG190A	† Siliconix
		50	-7.5 to 15	±15,5	DG190B	Siliconix
			-12.5 to 15	-20,10,-5	DG190B	Siliconix
		75	-10 to 15	±15,5	DG191A	† Intersil
					IH191M	† Intersil
					DG191A	† Siliconix
			-15 to 10	-20,10,-5	DG191A	† Intersil
					IH191M	† Intersil
					DG191A	† Siliconix
		100	-10 to 15	±15,5	DG191B	Intersil
					IH191C	Intersil
					DG191B	Siliconix
			-15 to 10	-20,10,-5	DG191B	Intersil
					IH191C	Intersil
					DG191B	Siliconix
		125	±10	±15,5	TL191M	† TI
		150	±10	±15,5	TL191I	TI
					TL191C	TI
3xSPDT	CMOS	280	±7.5	±7.5	F4053BC	Fairchild
					F4053BM	† Fairchild
					HD4053B-2	† Harris
					HD4053B-9	Harris
					MEM4053D	† GI
					MEM4053P	GI
					SIL4053B	† Mitel
					SIL4053BE	Mitel
					MC14053A	† Motorola
					MC14053C	Motorola
					CD4053C	National
					CD4053M	† National
					CD4053A	† RCA
					CD4053AE	RCA
					SCL4053A	† SSS
					SCL4053AE	SSS
					CM4053A	† Solitron
					CM4053AE	Solitron
					TP4053A/B	TI
					TC4053	Toshiba
	PMOS	200-800	±10	-20,10,-5	DG170A	† Siliconix
		250-850	±10	-20,10,-5	DG170B	Siliconix
					DG170C	Siliconix
4xSPDT for D/A	CMOS	100	0.1	8	**AD7519J**	**AD (430)**
	NMOS	—	—	8	DG515A	† Siliconix
				(Cont'd)	DG515B	Siliconix

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

INTERFACE—Analog Switches (Cont'd)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches with Drivers (Cont'd)						
4xSPDT	NMOS	—	—	(Cont'd)		
					DG515C	Siliconix
	NPN	—	-10 to -3	±15	ULN-2140	Sprague
					ULN-2141	Sprague
					ULN-2142	Sprague
					ULS-2140	† Sprague
					ULS-2141	† Sprague
					ULS-2142	† Sprague
	NPN-PNP	7	0 to -10	-15	CDA11-S12	Teledyne C
		10	0 to -10	-15	CDA11	Teledyne C
	NPN	—	—	—	AD550	† AD
					AD555	AD
	PNP	—	—	—	3240	Teledyne P
10xSPDT for D/A	NMOS	—	—	8	DG516A	† Siliconix
					DG516B	Siliconix
					DG516C	Siliconix
DPST	CMOS	75	±15	±15,5	1113	† DDC
					HI5044-2	**† Harris (433)**
					HI5044-5	**Harris (433)**
					IH5044C	Intersil
					IH5044M	† Intersil
2xDPST	CMOS	30	±11	±15,5	IH5049C	Intersil
					IH5049M	† Intersil
		50	±15	±15,5	**HI5049-2**	**† Harris (433)**
					HI5049-5	**Harris (433)**
				±15	DG302A	† Siliconix
					DG302B	Siliconix
					DG302C	Siliconix
					DG306A	† Siliconix
					DG306B	Siliconix
					DG306C	Siliconix
					DG384A	**† Siliconix (509)**
					DG384B	**Siliconix (509)**
					DG384C	**Siliconix (509)**
		75	±15	±15,5	1114	† DDC
					HI5045-2	**† Harris (433)**
					HI5045-5	**Harris (433)**
					IH5045C	Intersil
					IH5045M	† Intersil
2xDPST Three control input	CMOS	200	±15	±15,5	**HI1800A-2**	**† Harris (433)**
					HI1800A-5	**Harris (433)**
2xDPST	JFET	10	-7.5 to 15	±15,5	DG183A	† Siliconix
					DG183B	Siliconix
			±10	-18,12	DG140A	† Intersil
					AH0140	† National
					AH0140C	National
					DG140A	† Siliconix
			-12.5 to 10	-20,10,5	DG183A	† Siliconix
					DG183B	† Siliconix
		15	±7.5	±15	DG153A	† Intersil
					AH0153	† National
					AH0153C	National
					DG153A	† Siliconix
			±8	-18,12	DG440A	Intersil
				(Cont'd)		

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches with Drivers (Cont'd)						
2xDPST	JFET	15	±8	(Cont'd)		
					DG140B	Siliconix
		20	±5.5	±15	DG153B	Intersil
					DG453	Intersil
					DG153B	Siliconix
		30	-7.5 to 15	±15,5	DG184A	† Intersil
					IH184M	† Intersil
					DG184A	† Siliconix
			±10	-18,12	DG129A	† Intersil
					AH0129	† National
					AH0129C	National
					DG129A	† Siliconix
			-12.5 to 10	-20,10,-5	DG184A	† Intersil
					IH184M	† Intersil
					DG184A	† Siliconix
		35	±8	-18,12	DG429A	Intersil
		50	±7.5	±15	DG154A	† Intersil
					AH0154	† National
					AH0154C	National
					DG154A	† Siliconix
			±7.5 to 15	±15,5	DG184B	Intersil
					IH184C	Intersil
					DG184B	Siliconix
			±8	-18,12	DG129B	Siliconix
			-12.5 to 15	-20,10,-5	DG184B	Intersil
					IH184C	Intersil
					DG184B	Siliconix
		60	10	-18,5	CS4R101A	† Teledyne C
		75	-10 to 15	±15,5	DG185A	† Intersil
					IH185M	† Intersil
					DG185A	† Siliconix
			-15 to 10	-20,10,-5	DG185A	Intersil
					IH185M	† Intersil
					DG185A	† Siliconix
		80	±8	-18,12	DG426A	Intersil
			±10	-18,12	DG126A	† Intersil
					AH0126	† National
					AH0126C	National
					DG126A	† Siliconix
		100	±5.5	±15	DG154B	Intersil
					DG454A	Intersil
					DG154B	Siliconix
			±8	-18,12	DG126B	Siliconix
			-10 to 15	±15,5	DG185B	Intersil
					IH185C	Intersil
					DG185B	Siliconix
			-15 to 10	-20,10,-5	DG185B	Intersil
					IH185C	Intersil
					DG185B	Siliconix
		125	±10	±15,5	TL185M	† TI
		150	±10	±15,5	TL185I	TI
					TL185C	TI
				(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

DT' means four terminals with a pair of normally open and normally closed contacts.

INTERFACE—Analog Switches (Cont'd)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches with Drivers (Cont'd)						
2xDPST				(Cont'd)		
2xDPST Common output	PMOS	100-450	±10	-20,10,5	DGM122A	† Siliconix
		125-500	±10	-20,10,5	DGM122B	Siliconix
		200-600	±10	-20,10,5	AH0019	† National
					AH0019C	National
3xDPST Common output	PMOS	100-450	±10	-20,10	DG120	† Intersil
				-20,10,5	DG121	† Intersil
DPDT[1]	CMOS	50	±15	±15,5	**HI5046A-2**	**† Harris (433)**
					HI5046A-5	**Harris (433)**
		75	±15	±15,5	1115	† DDC
					HI5046-2	**† Harris (433)**
					HI5046-5	**Harris (433)**
					IH5046C	Intersil
					IH5046M	† Intersil
	JFET	10	±10	-18,12	DG145A	† Intersil
					AH0145	† National
					AH0145C	National
					DG145A	† Siliconix
		15	±7.5	±15	DG163A	† Intersil
					AH0163	† National
					AH0163C	National
					DG163A	† Siliconix
			±8	-18,12	DG445A	Intersil
					DG145B	Siliconix
		20	±5.5	±15	DG163B	Intersil
					DG463A	Intersil
					DG163B	Siliconix
		30	±10	-18,12	DG139A	† Intersil
					AH0139	† National
					AH0139C	National
					DG139A	† Siliconix
		35	±8	-18,12	DG439A	Intersil
		50	±7.5	±15	DG164A	† Intersil
					AH0164	† National
					AH0164C	National
					DG164A	† Siliconix
			±8	-18,12	DG139B	Siliconix
		80	±8	-18,12	DG442A	Intersil
			±10	-18,12	DG142A	† Intersil
					AH0142	† National
					AH0142C	National
					DG142A	† Siliconix
		100	±5.5	±15	DG164B	Intersil
					DG464A	Intersil
					DG164B	Siliconix
			±10	-18,12	DG142B	Siliconix
2xDPDT	PMOS		±7	-5,-21	TDA1195	Siemens
DPDT	PMOS	150-450	±10	-20,10,5	DG173A	† Siliconix
		150-500	±10	-20,10,5	DG173B	Siliconix
		200-600	±10	-20,10,5	AH0014	† National
					AH0014C	National
				(Cont'd)		

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches with Drivers (Cont'd)						
DPDT	PMOS			(Cont'd)		
		200-275	±10	-28,5,12	CRC9505	Collins
4PST	CMOS	50	±15	±15,5	**HI5047A-2**	**† Harris (433)**
					HI5047A-5	**Harris (433)**
		75	±15	±15,5	**HI5047-2**	**† Harris (433)**
					HI5047-5	**Harris (433)**
					1116	† DDC
					IH5047C	Intersil
					IH5047M	† Intersil
4PDT for D/A	JFET	10	±10	±15,5	CDA28A	† Teledyne C
Switches without Drivers						
SPST	JFET	30	±10		AM1000	† National
		50	±10		2110B	Teledyne C
			±15		AM1001	† National
		100	±0.2		IH5021C	Intersil
					IH5021M	† Intersil
					IH5023C	Intersil
					IH5023M	† Intersil
			0 to (Drive-4)			
					1105C-1	DDC
					1105M-1	† DDC
					IH5037C	Intersil
					IH5037M	† Intersil
			±5		2107B	Teledyne C
			±10		AM1002	† National
		150	±0.2		1101C-1	DDC
					1101M-2	† DDC
					1101C-2	DDC
					1101M-2	† DDC
					IH5022C	Intersil
					IH5022M	† Intersil
					IH5024C	Intersil
					IH5024M	† Intersil
			0 to (Drive-4)			
					1105C-2	DDC
					1105M-2	† DDC
					IH5038C	Intersil
					IH5038M	† Intersil
2xSPST	JFET	100	±0.2		IH5017C	Intersil
					IH5017M	† Intersil
			0 to (Drive-4)			
					1106C-3	DDC
					1106M-3	† DDC
					IH5033C	Intersil
					IH5033M	† Intersil
		150	±0.2		1102C-2	DDC
					1102M-1	† DDC
					IH5020C	Intersil
					IH5020M	† Intersil
			0 to (Drive-4)			
					1106C-2	DDC
					1106M-2	† DDC
				(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

INTERFACE—Analog Switches (Cont'd)

Switches without Drivers (Cont'd)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
2xSPST	JFET	150	±0.2	(Cont'd)		
					IH5036C	Intersil
					IH5036M	† Intersil
2xSPST Common output		100	±0.2		IH5019C	Intersil
					IH5019M	† Intersil
			0 to (Drive-4)			
					1106C-1	DDC
					1106M-1	† DDC
					IH5035C	Intersil
					IH5035M	† Intersil
		150	±0.2		1102C-1	DDC
					1102M-1	† DDC
					IH5018C	Intersil
					IH5018M	† Intersil
			0 to (Drive-4)			
					1106C-4	DDC
					1006M-4	† DDC
					IH5034C	Intersil
					IH5034M	† Intersil
3xSPST	JFET	100	±0.2		IH5015C	Intersil
					IH5015M	† Intersil
					AH5015C	National
			0 to (Drive-4)			
					1107C-1	DDC
					1107M-1	† DDC
					IH5031C	Intersil
					IH5031M	† Intersil
		150	±0.2		1103C-2	DDC
					1103M-2	† DDC
					IH5016C	Intersil
					IH5016M	† Intersil
					AH5016C	National
			0 to (Drive-4)			
					1107C-2	DDC
					1107M-2	† DDC
3xSPST Common output		100	±0.2		IH5013C	Intersil
					IH5013M	† Intersil
					AH5013C	National
			0 to (Drive-4)			
					1107C-3	DDC
					1107M-3	† DDC
					IH5029C	Intersil
					IH5029M	† Intersil
		150	±0.2		1103C-1	DDC
					1103M-1	† DDC
					IH5014C	Intersil
					IH5014M	† Intersil
					AH5014C	National
			0 to (Drive-4)			
					1107C-4	DDC
					1107M-4	† DDC
					IH5030C	Intersil
					IH5030M	† Intersil
3xSPST	PMOS	200-600			MM455	† Intersil
					MM555	Intersil
				(Cont'd)		

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches without Drivers (Cont'd)						
3xSPST	PMOS	200-600		(Cont'd)		
					MM455	† National
					MM555	National
4xSPST	DMOS	45	±5		SD5001	Signetics
			±10		SD5000	Signetics
4 x SPST	JFET	100	±0.2		IH5011C	Intersil
					IH5011M	† Intersil
					AH5011C	National
					AM97C11C	National
					AM9711C	National
			0 to (Drive-4)			
					1108C-1	DDC
					1108M-1	† DDC
					IH5027C	Intersil
					IH5027M	† Intersil
		150	±0.2		1104C-2	DDC
					1104M-2	† DDC
					IH5012C	Intersil
					IH5012M	† Intersil
					AH5012C	National
					AM97C12C	National
					AM9712C	National
			0 to (Drive-4)			
					1108C-2	DDC
					1108M-2	† DDC
					IH5028C	Intersil
					IH5028M	† Intersil
		—			G125	† Intersil
					G126	† Intersil
					G127	† Intersil
					G128	† Intersil
					G1330	Intersil
					G1340	Intersil
					G125A	† Siliconix
					G126A	† Siliconix
					G127A	† Siliconix
					G128A	† Siliconix
					G128B	Siliconix
4xSPST Common Output	DMOS	45	±5		SD5101	Signetics
			±10		SD5100	Signetics
4xSPST Common output	JFET	100	±0.2		IH5009C	Intersil
					IH5009M	† Intersil
					AH5009C	National
					AM97C09C	National
					AM9709C	National
			0 to (Drive-4)			
					1108C-3	DDC
					1108M-3	† DDC
					IH5025C	Intersil
					IH5025M	† Intersil
		150	±0.2		1104C-1	DDC
					1104M-1	† DDC
					IH5010C	Intersil
					IH5010M	† Intersil
					AH5010C	National
				(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

DT¹ means four terminals with a pair of normally open and normally closed contacts.

INTERFACE—Analog Switches (Cont'd)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches without Drivers (Cont'd)						
4xSPST Common output	JFET	150	±0.2	(Cont'd)		
					AM97C10C	National
					AM9710C	National
			0 to (Drive-4)			
					1108C-4	DDC
					1108M-4	† DDC
					IH5026C	Intersil
					IH5026M	† Intersil
		—			IH5026M	† Intersil
					G130	† Intersil
					G131	† Intersil
					G132	† Intersil
					G1350	Intersil
					G1360	Intersil
					G129A	† Siliconix
					G130A	† Siliconix
					G131A	† Siliconix
					G132A	† Siliconix
4xSPST Two Outputs	JFET	—			G123	Intersil
4xSPST	PMOS	200-600			MM452	† Intersil
					MM552	Intersil
4xSPST Common output	PMOS	—			MM451	† Intersil
					MM551	Intersil
					MM451	† National
					MM551	National
					G124A	† Siliconix
					G124B	Siliconix
4xSPST Two outputs	PMOS	—			G123A	† Siliconix
					G123B	Siliconix
5xSPST Common output	PMOS	—			G116C	Intersil
					G116M	† Intersil
					G116A	† Siliconix
					G116B	Siliconix
5xSPST Common output plus output switch	PMOS	—			G117C	Intersil
					G117M	† Intersil
					G117A	† Siliconix
					G117B	Siliconix
6xSPST Common output	PMOS	—			AM2009	† National
					CRC9509	Collins
					AM2009C	National
					MM5504	† National
					MM4504	National
					G115	Intersil
					G118C	Intersil
					G118M	† Intersil
					G115A	† Siliconix
					G115B	Siliconix
					G118A	† Siliconix
					G118B	Siliconix
10xSPST 3 outputs	NMOS	—			NMX5010	SMC
10xSPST	PMOS	—			CRC9510	Collins
				(Cont'd)		

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Switches without Drivers (Cont'd)						
10xSPST		—		(Cont'd)		
2xDPST Common output	PMOS	—			G122A	† Siliconix
					G122B	Siliconix
					MM450	† Intersil
					MM550	Intersil
					MM450	† National
					MM550	National
3xDPST Common output	PMOS	—			G119C	Intersil
					G119M	† Intersil
					G119A	† Siliconix
					G119B	Siliconix
Multiplexers						
4 channel differential						
	CMOS	270	±7.5	±7.5	HD14529B-2	† Harris
					HD14529B-9	Harris
					MC14529A	† Motorola
					MC14529C	Motorola
		280	±7.5	±7.5	F4052BC	Fairchild
					F4052BM	† Fairchild
					HD4052B-2	† Harris
					HD4052B-9	Harris
					SIL4052B	† Mitel
					SIL4052BE	Mitel
					MC14052BA	† Motorola
					MC14052BC	Motorola
					CD4052BC	National
					CD4052BM	† National
					CD4052B	† RCA
					CD4052BE	RCA
					SCL4052B	† SSS
					SCL4052BE	SSS
					CM4052B	† Solitron
					CM4052BE	Solitron
					TF4052A/B	† TI
					TP4052A/B	TI
					TC4052	Toshiba
		300	±15	±15	**AD7502J**	**AD** (431)
					AD7502K	**AD** (431)
					AD7502S	**† AD** (431)
		400	±15	±15	**HI1828A-2**	**† Harris** (432)
					HI1828A-5	**Harris** (432)
					DG509A	† Intersil
					DG509A	† Siliconix
		450	±15	±15	DG509B	Intersil
					DG509C	Intersil
					DG509B	Siliconix
					DG509C	Siliconix
		1300	±15	±15	MPC-4D	Burr-Brown
		1500	±15	±15	**HI509A-2**	**† Harris** (432)
					MXD-409	Datel
		1800	±15	±15	**HI509A-5**	**Harris** (432)
	JFET	300	±10	±15,5	LF11306	† National
					LF12306	National
					LF13306	National
				(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

INTERFACE—Analog Switches (Cont'd)

Multiplexers (Cont'd)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
4 channel	JFET			(Cont'd)		
		350*	-15,12	±15	LF11509	† National
					LF12509	National
					LF13509	National
4 channel Sequential Commutator						
	PMOS	200-600	±10	-24,12	MM454	† National
					MM554	National
6 channel						
	JFET	60	±10	-18,2.8	CAM601A	† Teledyne C
8 channel						
	CMOS	150	±8	±8	MS504	Ragen
		270	±7.5	±7.5	HD14529B-2	† Harris
					HD14529B-9	Harris
					MC14529A	† Motorola
					MC14529C	Motorola
		280	±7.5	±7.5	F4051BC	Fairchild
					F4051BM	† Fairchild
					HD4051B-2	† Harris
					HD4051B-9	Harris
					MEM4051D	† GI
					MEM4051P	GI
					SIL4051B	† Mitel
					SIL4051BE	Mitel
					MC14051BA	† Motorola
					MC14051BC	Motorola
					CD4051BC	National
					CD4051BM	† National
					CD4051B	† RCA
					CD4051BE	RCA
					SCL4051B	† SSS
					SCL4051BE	SSS
					CM4051A	† Solitron
					CM4051AE	Solitron
					TF4051A/B	† TI
					TP4051A/B	TI
					TC4051	Toshiba
		300	±15	±15	**AD7501J**	**AD** (431)
					AD7501K	**AD** (431)
					AD7501S	**† AD** (431)
					AD7503J	**AD** (431)
					AD7503K	**AD** (431)
					AD7503S	**† AD** (431)
		400	±15	±15,5	**HI1818A-2**	**† Harris** (432)
					HI1818A-5	**Harris** (432)
				±15	DG508A	† Intersil
					DG508A	† Siliconix
		450	±15	±15	DG508B	Intersil
					DG508C	Intersil
					DG508B	Siliconix
					DG508C	Siliconix
		1300	±15	±15	MPC-8S	Burr-Brown
		1500	±15	±15	MN4708	Analogic
					MX-808	Datel
					HI508A-2	**† Harris** (432)
					MUX202	Hybrid Sys
					MUX203M	† Hybrid Sys
		1800	±15	±15	**HI508A-5**	**Harris** (432)
	JFET	300	±10	±15,5 (Cont'd)	LF11305	† National
				(Cont'd)	LF12305	National
					LF13305	National
		350*	-15,12	±15	LF11508	† National
					LF12508	National
					LF13508	National
	PMOS	150-250	±5	-20,5	DG501A	† Siliconix
					DG501B	Siliconix
					DG501C	Siliconix
		150-400	±5	-20,5	3705	Fairchild
					SI3705	Siliconix
		150-800	±10	-20,10	DG503A	† Siliconix
					DG503B	Siliconix
		200-600	±5	-15,5	DG501A	† Siliconix
		200-800	±5	-15,5	DG501B	Siliconix
					DG501C	Siliconix
		250-400	±5	-15,5	AM3705	† National
					AM3705	National
		450	-15	-20	3708	Fairchild
					ITT3708	ITT
8 channel differential						
	CMOS	280	±7.5	±7.5	CD4097B	† RCA
					CD4097BE	RCA
		400	±15	±15	**AD7507J**	**AD** (431)
					AD7507K	**AD** (431)
					HI507-2	**† Harris** (432)
					HI507-5	**Harris** (432)
					IH5070M	† Intersil
					DG507A	† Siliconix
		450	±15	±15	**AD7507S**	**† AD** (431)
					AD7507T	**† AD** (431)
					IH5070C	Intersil
					DG507B	Siliconix
					DG507C	Siliconix
		1300	±15	±15	MPC-8D	Burr-Brown
		1500	±15	±15	1507M	† DDC
					MXD-807	Datel
					HI507A-2	**† Harris** (432)
		1800	±15	±15	MN4708D	Analogic
					1507C	DDC
					HI507A-5	**Harris** (432)
					4551	Teledyne P
8 channel (DPST) with ring counter						
	PMOS	500,6800		-12,5	CRC2002	Collins
8 channel differential with storage/counter						
		750	±5	-12,5	AY5-1016	GI
					AY6-4016	† GI
16 channel						
	CMOS	280	±7.5	±7.5	F4067BC	Fairchild
					F4067BM	Fairchild
					CD4067B	† RCA
					CD4067BE	RCA
		400	±15	±15	**AD7506S**	**† AD** (431)
					AD7506T	**† AD** (431)
					HI506-2	**† Harris** (432)

† Military Temperature Range (−55°C to 125°C)

DT' means four terminals with a pair of normally open and normally closed contacts.

INTERFACE—Analog Switches (Cont'd)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Multiplexers (Cont'd)						
16 channel	CMOS	400	±15	(Cont'd)		
					HI506-5	**Harris (432)**
					IH5060M	† Intersil
					DG506A	† Siliconix
		450	±15	±15	**AD7506J**	**AD (431)**
					AD7506K	**AD (431)**
					IH5060C	Intersil
					DG506B	Siliconix
					DG506C	Siliconix
		1300	±15	±15	MPC-16S	Burr-Brown
		1500	±15	±15	1506M	† DDC
					MX-1606	Datel
					HI506A-2	**† Harris (432)**
					MUX204	Hybrid Sys
		1800	±15	±15	MN4716	Analogic
					1506C	DDC
					HI506A-5	**Harris (432)**
					4552	Teledyne P
16 channel with storage counter	PMOS	750	±5	-12,5	AY5-1016	GI
					AY6-4016	† GI
Crosspoint Switches						
					MC3416	Motorola
					RC4444	Raytheon
					RM4444	† Raytheon
					TA6249	RCA
					SD5300	Signetics
Drivers						
2 channel						
					D112C	Intersil
					D112M	† Intersil
					D113C	Intersil
					D113M	† Intersil
					D120C	Intersil
					D120M	† Intersil
					D121C	Intersil
					D121M	† Intersil
					D130A	† Siliconix
					D130B	Siliconix
					D139A	† Siliconix
					D139B	Siliconix
					D139C	Siliconix
4 channel						
					D129	Intersil
					D129A	† Siliconix
					D129B	Siliconix
4 channel for DMOS						
					SD5200	Signetics
4 channel with Decoder						
					D132A	† Siliconix
					D132B	Siliconix
6 channel						
					D123C	Intersil
					D123M	† Intersil
					D125C	Intersil
					D125M	† Intersil

(Cont'd)

Function	Switch Type	ON Resistance 25°C, Ω	Analog Signal Range, V	Supply Voltage	Device	Source
Drivers (Cont'd)						
6 channel				(Cont'd)		
					D123A	† Siliconix
					D123B	Siliconix
					D125A	† Siliconix
					D125B	Siliconix
					CDR125A	† Teledyne C
					CDR125B	Teledyne C

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

INTERFACE—Analog to Digital Converters

Bits	Conversion Time µs	Linearity Error ±%FS	Supply Voltage	Device	Source
Binary Output					
8-Bit Binary					
	2.5	0.2	±12,5	MN5143	Micro Net
				MN5143H	† Micro Net
			±12,5	MN5133	Micro Net
				MN5133H	† Micro Net
	6	0.2	±15,5	MN5123	Micro Net
	12	0.2	±15,5	MN502	Micro Net
				MN502H	† Micro Net
			±12,5	MN508	Micro Net
				MN508H	† Micro Net
			±15,5	MN510	Micro Net
				MN510H	Micro Net
	40	0.2	-12,5	MM4357	† National
				MM5357	National
		0.4	-12,5	MM4357B	† National
				MM5357B	National
	100	0.2	12	MN5061	Micro Net
				MN5061H	† Micro Net
	Integrating				
	1800	0.2	±5	ADC-EK8B	Datel
				ADC586-8	Hybrid Sys
				8700	Teledyne S
				8703	Teledyne S
8-Bit Complementary Binary					
	1.5	0.2	±15,5	MN5100	Micro Net
				MN5100H	† Micro Net
	2.5	0.2	±12,5	MN5140	Micro Net
				MN5140H	† Micro Net
			±12,5	MN5130	Micro Net
				MN5130H	† Micro Net
	6	0.2	±15,5	MN5120	Micro Net
			±15,5	MN5120H	† Micro Net
	12	0.2	±15,5	MN504	Micro Net
				MN504H	† Micro Net
	100	0.2	12,5-12	MN5066	Micro Net
				MN5066H	† Micro Net
8-Bit Complementary Offset Binary					
	12	0.2	±15,5	MN503	Micro Net
				MN503H	† Micro Net
				MN507	Micro Net
				MN511	Micro Net
				MN511H	† Micro Net
			±12,5	MN509	Micro Net
	100	0.2	12,5-12	MN5065	Micro Net
				MN5065H	† Micro Net
	Multiplex Input				
	7	0.2	±15,5	MN7100	Micro Net
8-bit Offset Binary					
	2.5	0.2	±15,5	MN5131	Micro Net
			±15,5	MN51314	† Micro Net
			±15,5	MN5132	Micro Net
			±15,5	MN5132H	† Micro Net
			±12,5	MN5141	Micro Net
			±12,5	MN51414	† Micro Net
			±12,5	MN5142	Micro Net
			±12,5	MN51424	† Micro Net
	6	0.2	±15,5	MN5121	Micro Net
			(Cont'd)		

Bits	Conversion Time µs	Linearity Error ±%FS	Supply Voltage	Device	Source
Binary Output (Cont'd)					
8-bit Offset Binary			(Cont'd)		
				MN5121H	† Micro Net
				MN5122	Micro Net
				MN5122H	† Micro Net
	100	0.2	12	MN5060	Micro Net
				MN5060H	† Micro Net
8-Bit Complementary Binary/Comp. Offset Binary/Comp. Two's Complement					
	0.9	0.2	±15,5	MN5101	Micro Net
	2.8	0.2	±15,5	ADC82	Burr-Brown
8-Bit Binary/Offset Binary/Two's Complement					
	8	0.2	±15,5	AD-02	PMI
				AD-02W	† PMI
10-Bit Binary					
	16*	0.2	15,5-15	**AD7570J**	**AD** (426)
	20*	0.05	15,5-15	**AD7570L**	**AD** (426)
	Integrating				
	6000	0.05	±15	ADC-EK10B	Datel
				ADC586-10	Hybrid Sys
				8701	Teledyne S
				8704	Teledyne S
10-Bit Binary/Two's Complement - Stochastic					
	200ms	0.2	-12,5	AY5-5053	GI
				AY5-5054	GI
10-Bit Complementary Binary/Comp. Offset Binary/Comp. Two's Complement					
	21	0.05	±15,5	ADC80A-10	Burr-Brown
				ADC80A-10	Micro Net
11-Bit Binary					
	12	—	±15,5	876-U	† Beckman
11-Bit Offset Binary					
	12	—	±15,5	876-B	† Beckman
12-Bit Binary					
	13	0.0125	±15,5	MN5210	Micro Net
				MN5210H	† Micro Net
				MN5213	Micro Net
				MN5213H	† Micro Net
	Building Block				
	15	—	±15,5	AD1200	National
	50	0.0125	±15,5	MN5200	Micro Net
				MN5203	Micro Net
				MN5203H	† Micro Net
			3-15	AD1210	National
	175	0.0125	±12,5-12	MN5250	Micro Net
				MN5250H	† Micro Net
	Integrating				
	24ms	0.0125	±5	ADC-EK12B	Datel
				ADC586-12	Hybrid Sys
				8702	Teledyne S
				8704	Teledyne S
	Dual Slope, 2 Devices				
	20ms	0.0125	±15,5	LF11300	National
			-15,5	MM5863	National
			(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

* Typical Values

INTERFACE—Analog to Digital Converters (Cont'd)

Bits	Conversion Time µs	Linearity Error ±%FS	Supply Voltage	Device	Source
Binary Output (Cont'd)					
12-Bit Binary (Cont'd)					
12-Bit Complementary Binary					
	13	0.0125	±15,5	MN5216	Micro Net
				MN5216H	† Micro Net
	50	0.0125	±15,5	MN5206	Micro Net
				MN5206H	† Micro Net
	175	0.0125	±12,5-12	MN5253	Micro Net
				MN5253H	† Micro Net
12-Bit Complementary Offset Binary					
	13	0.0125	±15,5	MN5211	Micro Net
				MN5211H	† Micro Net
				MN5212	Micro Net
				MN5212H	† Micro Net
				MN5214	Micro Net
				MN5214H	† Micro Net
				MN5215	Micro Net
				MN5215H	† Micro Net
	50	0.0125	±15,5	MN5201	Micro Net
				MN5201H	† Micro Net
				MN5202	Micro Net
				MN5202H	† Micro Net
				MN5204	Micro Net
				MN5204H	† Micro Net
				MN5205	Micro Net
				MN5205H	† Micro Net
	175	0.0125	±15,5	MN5251	Micro Net
				MN5251H	† Micro Net
				MN5252	Micro Net
				MN5252H	† Micro Net
12-Bit Complementary Binary/Comp. Offset Binary					
	40	0.012	±15,5	873-88	Beckman
	50	0.012	±15,5	873-78	Beckman
12-Bit Complementary Binary/Comp. Offset Binary/Comp. Two's Complement					
	6	0.05	±15,5	ADC85-10	Burr-Brown
				ADC84-10	Burr-Brown
	8	0.0125	±15,5	ADC-HZ12B	Datel
				ADC-HZ12BM	† Datel
	10	0.012	±15,5	ADC85-12	Burr-Brown
				ADC84-12	Burr-Brown
	20	0.0125	±15,5	ADC-HX12B	Datel
				ADC-HX12BM	† Datel
	25	0.0125	±15,5	ADC80A-12	Burr-Brown
				ADC80A-12	Micro Net
12-Bit Binary/Offset Binary/Two's Complement (6-8 bit accuracy)					
	—	0.2	±15,5	AD-02	PMI
				AD-02W	† PMI
13-Bit Two's Complement					
Multiple Integration, 5/8-Bit Serial Output					
	40ms *	0.006	±5,12	**AD7550**	**AD** **(424)**
Binary Output (Cont'd)					
16-Bit Binary					
Dual Slope, 2 Devices					
	250ms	—	±15,5	7104	Intersil
				8052	Intersil
16-Bit Various Codes, Building Block					
	—	—	±15,5	8052	Intersil
				8053	Intersil

† Military Temperature Range (−55°C to 125°C)

* Typical Values

Bold face indicates additional data is provided on the page noted.

INTERFACE—Analog to Digital Converters

Digits	Device	Source
Decimal Output		
2½ Digits, v to f Converter		
	DM7700	† National
	DM8700	National
3 Digits, Integrating		
	LD130	**Siliconix (502)**
3½ Digits, Dual Slope		
	MN2301	Analogic
	MC904	IPI
3½ Digits, Dual Slope, 2 device sets		
	7101	Intersil
	8052	Intersil
	8053	Intersil
	TL500	TI
	TL502	TI
3½ Digits, Integrating		
	ADC-EK12D	Datel
	MC14433	Motorola
	LD131	**Siliconix (502)**
	8750	Teledyne S
3½ Digits, Ramp Type, 2 device sets		
	LD110	Intersil
	LD111	Intersil
	LD114	Intersil
	LD110	**Siliconix (502)**
	LD111	**Siliconix (502)**
	LD114	**Siliconix (502)**
3-1/2 Digits, 2 device set		
	MPS7104	Micro Power
	MPS5007	Micro Power
3-3/4 Digits, Dual Slope		
	S190	Siemens
3½-4½ Digits, Ramp Type, 2 device sets		
	MC1405	Motorola
	MC1505	† Motorola
	MC14435	Motorola
	MC14435E	† Motorola
4½ Digits, Dual Slope		
	7103	Intersil
4½ Digits, Dual Slope, 2 device sets		
	8052A	Intersil
	8055A	Intersil
	LF11300	National
	MM5330	National

Bits	Device	Source
Decimal Output		

† Military Temperature Range (−55°C to 125°C)

* Typical Values

INTERFACE—Digital to Analog Converters

Bits	Settling Time (±½LSB) µs	Linearity Error % FPS	Supply Voltage	Device	Source
D/A Converters					
6-Bit Binary					
	Multiplying 0.25*	0.78	-(5-15),5	SSS1408A-6	PMI
	Multiplying 0.3*	0.78	-(5-15),5	MC1408-6	Motorola
6-Bit Complementary Binary/ Complementary Offset Binary					
	Multiplying 0.3	0.78	-(5-15),5	MC1406	Motorola
				MC1506	† Motorola
	3	0.3	±(12-18)	DAC-01A	† PMI
		0.45	±(12-18)	DAC-01	† PMI
				DAC-01B	† PMI
				DAC-01C	PMI
				DAC-01F	† PMI
				DAC-01H	PMI
	23*	0.78	±15,5	MN301	Micro Net
				MN301H	† Micro Net
7-Bit Binary					
	Multiplying 0.25*	0.39	-(5-15),5	SSS1408A-7	PMI
	Multiplying 0.3*	0.39	-(5-15),5	MC1408-7	Motorola
				MC1408-7	Signetics
8-Bit BCD					
	23	0.5	±15	MN3010	Micro Net
				MN3010H	† Micro Net
8-Bit Binary					
	Multiplying 0.25*	0.19	-(5-15),5	SSS1408A-8	PMI
				SSS1508-8	† PMI
	Multiplying 0.3*	0.19	-(12-15),5	**AD559K**	**AD (416)**
				AD559S	**† AD (416)**
			-(5-15),5	DAC-IC8BC	Datel
				DAC-IC8BM	† Datel
				MC1408-8	Motorola
				MC1508-8	† Motorola
				MC1408-8	Signetics
				MC1508-8	† Signetics
		0.5	-(5-15),5	MC3408	Motorola
	1	0.2	±15	MN3008	Micro Net
				MN3008H	† Micro Net
	1.5	0.2	3-10	DAC331M-8	† Hybrid Sys
	2.5	0.2	±15	MN3014	Micro Net
	23	0.2	±15	MN3002	Micro Net
				MN3002H	† Micro Net
			±15,5	MN328	Micro Net
	35	0.2	±15	MN3013	Micro Net
	52	0.2	±15	845-U5	Beckman
	102	0.2	±15	845-U10	Beckman
			(Cont'd)		

Bits	Settling Time (±½LSB) µs	Linearity Error % FPS	Supply Voltage	Device	Source
D/A Converters (Cont'd)					
8-Bit Binary			(Cont'd)		
8-bit Binary, Unipolar or Bipolar					
Input Register	3	0.2	±15,5	MN3020	Micro Net
				MN3020H	† Micro Net
8-Bit Complementary Binary	0.1	0.2	±15,5,10	MN306	Micro Net
			5,15	MN333	Micro Net
	0.225	0.2	±(6-18)	DAC-100C	PMI
				DAC-100C	† PMI
		0.3	±(6-18)	DAC-100D	PMI
				DAC-100D	† PMI
	23	0.2	±15	MN3000	Micro Net
				MN3000H	† Micro Net
				MN3001	Micro Net
				MN3001	Micro Net
				MN3001H	† Micro Net
			±15,5	MN328B	Micro Net
	45	0.2	±15	MN3006	Micro Net
				MN3006H	† Micro Net
			±15,5	MN335	Micro Net
	52	0.2	±15	845-B5	Beckman
	102	0.2	±15	845-B10	Beckman
8-Bit Binary/Complementary Binary					
Multiplying, High Compliance	0.1	0.1	±(5-18)	NE5009	Signetics
				SE5009	† Signetics
Multiplying, High Compliance	0.135	0.1	±(5-18)	DAC-08A	† PMI
Multiplying, High Compliance	0.1*	0.19	±(5-18)	DAC-08	AMD
				DAC-08	PMI
				DAC-08	† PMI
				NE5008	Signetics
				SE5008	† Signetics
		0.39	±(5-18)	DAC-08CZ	PMI
				NE5007	Signetics
Multiplying	3	0.2	3-10	DAC331-8	† Hybrid Sys.
8-Bit Complementary Binary/ Complementary Offset Binary	0.2	0.2	±15	DAC90L	Burr-Brown
				DAC90T	† Burr-Brown
		0.4	±15	DAC90K	Burr-Brown
				DAC90S	† Burr-Brown
		0.8		DAC90J	Burr-Brown
				DAC90R	† Burr-Brown
8-Bit (7-Bits plus Sign) Companding	0.5	—	±15	DAC-76	† PMI
				DAC-76B	† PMI
				DAC-76C	PMI
				DAC-76E	PMI
8-Bit Binary Ladder	1.5*	—	—	HI1085	Harris
			(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

* Typical Values

Bold face indicates additional data is provided on the page noted.

INTERFACE—Digital to Analog Converters (Cont'd)

D/A Converters (Cont'd)

Bits	Settling Time (±½LSB) µs	Linearity Error % FPS	Supply Voltage	Device	Source
8-Bit Binary Ladder (Cont'd)					
	3	—	—	HI1080	† Harris
9-Bit plus Sign Offset Binary					
	Multiplying				
	15	0.1	±15,5	MN411	Micro Net
				MN411H	† Micro Net
	45	0.1	±15,5	MN410	Micro Net
				MN410H	† Micro Net
10-Bit BCD					
	23	0.05	±15,5	MN319	Micro Net
10-Bit Binary					
	0.25*	0.025	-15,5	**AD561K**	**AD** (417)
			-15,5	**AD561T**	**† AD** (417)
		0.05	-15,5	**AD561J**	**AD** (417)
			-15,5	**AD561S**	**† AD** (417)
	Multiplying, -2.5v Compliance				
	0.25*	0.05	-15,5	MC3410	Motorola
				MC3510	† Motorola
		0.1	-15,5	MC3410C	Motorola
	Monotonicity 7-10 Bits				
	0.1	—	± (12-18)	DAC-03AD	PMI
				DAC-03BD	PMI
	0.2	—	± (12-18)	DAC-03CD	PMI
	0.4	—	± (12-18)	DAC-03DD	PMI
	Multiplying				
	1.5	0.05	±15	DAC331M-10	† Hybrid Sys
	23	0.05	±15	MN3005	Micro Net
				MN3005H	† Micro Net
	Multiplying				
	50	0.05	±15	MN3100	Micro Net
10-Bit Complementary Binary					
	0.1	0.05	5,15	MN325	Micro Net
	0.375	0.05	± (6-18)	DAC-100A	PMI
				DAC-100A	† PMI
		0.1	± (6-18)	DAC-100B	PMI
				DAC-100B	† PMI
	2*	0.05	±15	DAC345I	Hybrid Sys.
	5*	0.05	±15	DAC346V	Hybrid Sys.
				DAC346V	† Hybrid Sys.
	23	0.05	±15	MN3003	Micro Net
				MN3003H	† Micro Net
10-Bit Offset Binary					
	3	0.05	±15,5	MN329	Micro Net
	23	0.05	±15	MN3004	Micro Net
				MN3004H	† Micro Net
	45	0.05	±15	MN3007	Micro Net
				MN3007H	† Micro Net
10-Bit Binary/Offset Binary and Complements					
	Multiplying				
	0.5*	0.05	5-15	**AD7520L**	**AD** (420)
				AD7520U	**† AD** (420)
10-Bit Binary/Offset Binary and Complements (Cont'd)					
				AD7530L	**AD** (421)
		0.1	5-15	**AD7520K**	**AD** (420)
				AD7520T	**† AD** (420)
				AD7530K	**AD** (421)
		0.2	5-15	**AD7520J**	**AD** (420)
				AD7520S	**† AD** (420)
				AD7530J	**AD** (421)
	Multiplying, Latched Input				
		0.05	15,5-15	**AD7522L**	**AD** (422)
				AD7522U	**† AD** (422)
		0.1	15,5-15	**AD7522K**	**AD** (422)
				AD7522T	**† AD** (422)
		0.2	15,5-15	**AD7522J**	**AD** (422)
				AD7522S	**† AD** (422)
	Multiplying				
	3	0.05	3-10	DAC331-10	Hybrid Sys.
10-Bit Binary/Two's Complement					
	Stochastic				
	6800	0.2	-12,5	AY5-5053	GI
10-Bit Two's Complement					
	1.5*	0.1	± (12-18	DAC-04AC	PMI
				DAC-04BC	PMI
		0.2	± (12-18)	DAC-04CC	PMI
	2.5*	0.4	± (12-18)	DAC-04DD	PMI
11-Bit (10-Bit plus Sign)	1.5*	0.1	± (12-18)	DAC-02AC	PMI
				DAC-02BC	PMI
		0.2	± (12-18)	DAC-02CD	PMI
		0.4	± (12-18)	DAC-02DD	PMI
11-Bit (10-Bit plus Sign) Offset Binary					
	Multiplying				
	15*	0.05	±15,5	MN413	Micro Net
				MN413H	† Micro Net
	45*	0.05	±15,5	MN412	Micro Net
				MN412H	† Micro Net
11-Bit Binary					
	4.5	0.05	±15	848-U10	† Beckman
11-Bit Offset Binary					
	4.5	0.05	±15	848-B5	† Beckman
	7	0.05	±15	848-B10	† Beckman
12-Bit BCD					
	0.3/3*	0.025	±15	DAC-HZ12D	Datel
				DAC-HZ12DM	† Datel
		0.05	±15,5	DAC80/CCD	Burr-Brown
				DAC85/CCD	† Burr-Brown
				DAC85C/CCD	Burr-Brown
				DAC-S-CCD	DDC
				DAC80/CCD	Micro Net
				DAC85/CCD	Micro Net
	0.5	0.05	±15	MN311	Micro Net
				MN311H	† Micro Net
	Multiplying				
	1.2	0.025	-15,5-15	**AD563K/BCD**	**AD** (419)

† Military Temperature Range (−55°C to 125°C) * Typical Values

INTERFACE—Digital to Analog Converters (Cont'd)

D/A Converters (Cont'd)

Bits	Settling Time (±½LSB) µs	Linearity Error % FPS	Supply Voltage	Device	Source
12-Bit BCD	Multiplying 1.2	0.025	(Cont'd)	**AD563S/BCD** †	**AD (419)**
				AD563T/BCD †	**AD (419)**
		0.05	-15,5-15	**AD563J/BCD**	**AD (419)**
	3.0	0.01	-15,5-15	**AD562A/BCD**	**AD (418)**
				AD562K/BCD	**AD (418)**
				AD562S/BCD †	**AD (418)**
				AN562I/BCD	Analogic
				AN562S/BCD †	Analogic
		0.05	-15,5-15	AN562A/BCD	Analogic
				AN562K/BCD	Analogic
	3.5	0.01	±15,5	DA1202 †	National
				DA1202C	National
		0.05	±15,5	DA1203 †	National
				DA1203C	National
	23	0.05	±15	MN3212	Micro Net
12-Bit Binary	0.5	0.0125	±15	MN312	Micro Net
				MN312H †	Micro Net
	Multiplying 0.5*	0.05	5-15	**AD7531L**	**AD (421)**
		0.1	5-15	**AD7531K**	**AD (421)**
		0.2	5-15	**AD7531J**	**AD (421)**
	1	0.025	±5	MN312R	Micro Net
	Multiplying 1.2*	0.006	-15,5-15	**AD563K/BIN**	**AD (419)**
				AD563S/BIN †	**AD (419)**
				AD563T/BIN †	**AD (419)**
		0.012	-15,5-15	**AD563J/BIN**	**AD (419)**
	Multiplying 1.5	0.0125	3-10	DAC331M-12 †	Hybrid Sys
	3	0.012	±15,5	DA1200 †	National
				DA1200C	National
		0.048	±15,5	DA1201 †	National
				DA1201C	National
	Multiplying 3.5	0.006	-15,5-15	**AD562S/BIN** †	**AD (418)**
				AN562S/BIN †	Analogic
		0.012	-15,5-15	**AD562A/BIN**	**AD (418)**
				AD562K/BIN	**AD (418)**
				AN562A/BIN	Analogic
				AN562A/BIN	Analogic
	70	0.05	±15	MN371	Micro Net
				MN371H †	Micro Net
	Pulse Output 4ms	0.0125	±10	6202	Intersil
12-Bit Binary/Offset Binary	0.2/2	0.0125	±15	4058	† Teledyne P
	75	0.024	±15	872-D1	† Beckman
		0.05	±15	872-D2	† Beckman
	—	0.0125	±15	DAC349	Hybrid Sys
				DAC349M	† Hybrid Sys

(Cont'd)

D/A Converters (Cont'd)

Bits	Settling Time (±½LSB) µs	Linearity Error % FPS	Supply Voltage	Device	Source
12-Bit Binary/Offset Binary			(Cont'd)		
12-Bit Binary/Offset Binary and Complements					
	Multiplying 0.5*	0.05	5-15	**AD7521L**	**AD (420)**
				AD7521U †	**AD (420)**
		0.1	5-15	**AD7521K**	**AD (420)**
				AD7521T †	**AD (420)**
		0.2	5-15	**AD7521J**	**AD (420)**
				AD7521S †	**AD (420)**
12-Bit Complementary Binary	2*	0.0125	±15	DAC345I-12	Hybrid Sys.
	3	0.0125	±15,10	MN366	Micro Net
				MN366H †	Micro Net
	5*	0.0125	±15	DAC346V-12	Hybrid Sys.
				DAC346V-12 †	Hybrid Sys.
	7	0.0125	±15,10	MN362	Micro Net
				MN362H †	Micro Net
	35	0.0125	±15	MN3210	Micro Net
12-Bit Complementary Binary/Offset Binary	5*	0.0125	±15	MN3850	Micro Net
				MN3850H †	Micro Net
12-Bit Complementary Offset Binary	1*	0.0125	±15	DAC345I-12	Hybrid Sys.
				DAC345I-12 †	Hybrid Sys.
	3	0.0125	±15,10	MN364	Micro Net
				MN364H †	Micro Net
	7	0.0125	±5,10	MN360	Micro Net
				MN360H †	Micro Net
	35	0.0125	±15	MN3211	Micro Net
12-Bit Complementary Binary/Comp. Offset Binary/Comp. Two's Complement	0.3/3*	0.012	±15,5	877-85I	Beckman
				877-85V	Beckman
				DAC80/CBI	Burr-Brown
				DAC85/CBI	Burr-Brown
				DAC85ET †	Burr-Brown
				DAC-S-CBI	DDC
				DAC85/CBI †	Micro Net
			±15	DAC-HZ12B	Datel
				DAC-HZ12BM †	Datel
12-Bit Complementary Binary/Comp. Offset Binary	5	0.0122	±15,5	DA1200 †	National
				DA1200C	National
		0.048	±15,5	DA1201 †	National
				DA1201C	National
	5*	0.0125	±15,5	MN3860	Micro Net
				MN3860H †	Micro Net
12-Bit Offset Binary	5*		±15	DAC346V-12	Hybrid Sys.
				DAC346V-12 †	Hybrid Sys.
	70	0.0125	±15	MN370	Micro Net
				MN370H †	Micro Net

(Cont'd)

† Military Temperature Range (−55°C to 125°C)

* Typical Values

Bold face indicates additional data is provided on the page noted.

INTERFACE—Digital to Analog Converters (Cont'd)

Bits	Settling Time (±½LSB) µs	Linearity Error % FPS	Supply Voltage	Device	Source
D/A Converters (Cont'd)					
12-Bit Offset Binary (Cont'd)					
12-Bit plus sign dynamic range (7-Bit plus Sign Format)	0.5	—	±15	DAC-76	† PMI
13-Bit Binary					
Multiplying	20	—	-25,±15	877-69C	Beckman
				877-69M	† Beckman
13-Bit Complementary Binary/Comp. Offset Binary	0.1/0.37	0.0125	±5,15	SDAC-12	DDC
		0.025	±5,15	SDAC-11	DDC
		0.05	±5,15	SDAC-10	DDC
16-Bit BCD	10	0.005	±15	DAC-HP16D	Datel
	35	0.005	±15	MN3300	Micro Net
	50/100*	0.003	±15,5	DAC70/CCD	Burr-Brown
		0.005	±15,5	DAC70C/CCD	Burr-Brown
16-bit Complimentary Binary	10	0.005	±15	DAC-HP16B	Datel
	50/100*	0.003	±15,5	DAC70/CSB	Burr-Brown
		0.005	±15,5	DAC70C/CSB	Burr-Brown
16-Bit Complementary Offset Binary		0.003	±15,5	DAC70/COB	Burr-Brown
		0.005	±15,5	DAC70C/COB	Burr-Brown

Bits	Settling Time (±½LSB) µs	Linearity Error % FPS	Supply Voltage	Device	Source
D/A Converters					

† Military Temperature Range (−55°C to 125°C)

* Typical Values

INTERFACE—Display Drivers

Function	Device	Source	Line
Display Drivers			
BCD to 7-Segment LED Driver Adjustable Current			
	DS7858	National	
	DS8858	National	
BCD to 7-Segment LED Decoder/Driver, Constant Current			
	DS8857	National	
BCD to 7-Segment LED Latch/Decoder/Driver, with ripple blanking			
	F4734BC	Fairchild	
	F4734BM	† Fairchild	
BCD to 7-Segment LED Decoder/Driver, Constant Current, with Latch			
	9368C	Fairchild	10
	9374C	Fairchild	
Hex TTL to LED Bulb Driver, with Latch			
	DS8673	National	
	DS8674	National	
BCD to 7-Segment LCD Decoder/Driver			
	SIL4055B	† Mitel	
	CD4055B	† RCA	
	CD4055BE	RCA	
BCD to 7-Segment LCD Latch/Decoder/Driver			
	MC14543BA	† Motorola	
	MC14543BC	Motorola	
	SIL4056B	† Mitel	
	CD4056B	† RCA	20
	CD4056BE	RCA	
	SCL4543A	SSS	
BCD to 7-Segment Decoder/Driver, Active High, Resistive Pull-Up			
	54LS48	† Fairchild	
	74LS48	Fairchild	
	5448	† Fairchild	
	7448	Fairchild	
	9307C	Fairchild	
	9307M	† Fairchild	
	ITT5448	† ITT	30
	ITT7448	ITT	
	MC5448	† Motorola	
	MC7448	Motorola	
	MC8307	Motorola	
	MC9307	† Motorola	
	DM5448	† National	
	DM7448	National	
	DM54LS48	† National	
	DM74LS48	National	
	DS7856	† National	40
	DS8856	National	
	7448	Signetics	
	N8T05	Signetics	
	S8T05	† Signetics	
	SW7448	SW	
	TL7448	Telefunken	
	SN5448	† TI	
	SN54248	† TI	
	SN54LS48	† TI	
	SN54LS248	† TI	50
	SN7448	TI	
	SN74248	TI	
	SN74LS48	TI	
	SN74LS248	TI	

Function	Device	Source	Line
Display Drivers (Cont'd)			
BCD to 7-Segment Decoder/Driver, Active High, Open Collector			
	5449	† Fairchild	
	7449	Fairchild	
	54LS49	† Fairchild	
	74LS49	Fairchild	60
	MC5449	† Motorola	
	MC7449	Motorola	
	DM54LS49	† National	
	DM74LS49	National	
	N8T06	Signetics	
	S8T06	† Signetics	
	SN5449	† TI	
	SN54294	† TI	
	SN54LS49	† TI	
	SN54LS249	† TI	70
	SN7449	TI	
	SN74249	TI	
	SN74LS49	TI	
	SN74LS249	TI	
BCD to 7-Segment Decoder/Driver with latch, Active Low, Open Collector			
	9370C	Fairchild	
BCD to 7-Segment Decoder/Driver Active Low, Open Collector			
	MC4039	Motorola	
	N8T04	Signetics	
	S8T04	† Signetics	80
BCD to 7-Segment Decoder/Driver, Active Low, Open Collector, 15v Output			
	54LS47	† Fairchild	
	74LS47	Fairchild	
	5447	† Fairchild	
	7447	Fairchild	
	9317BC	Fairchild	
	9317BM	† Fairchild	
	HD2532	Hitachi	
	ITT5447	† ITT	
	ITT7447	ITT	90
	MC5447	† Motorola	
	MC7447	Motorola	
	DM5447A	† National	
	DM7447A	National	
	DM54LS47	† National	
	DM74LS47	National	
	7447	Signetics	
	SW7447	SW	
	SW7447A	SW	
	383A/C	Teledyne S	100
	383B/M	† Teledyne S	
	TL7447	Telefunken	
	SN5447A	† TI	
	SN54247	† TI	
	SN54LS47	† TI	
	SN54LS247	† TI	
	SN7447A	TI	
	SN74247	TI	
	SN74LS47	TI	
	SN74LS247	TI	110
BCD to 7-Segment Decoder/Driver, Active Low, Open Collector, 30v Output			
	5446	† Fairchild	
(Cont'd)			

Function	Device	Source	Line
Display Drivers (Cont'd)			
	7446	Fairchild	
	9317CC	Fairchild	
	9317CM	† Fairchild	
	HD2553	Hitachi	
	ITT5446	† ITT	
	ITT7446	ITT	
	MC5446	† Motorola	120
	MC7446	Motorola	
	DM5446A	† National	
	DM7446A	National	
	7446	Signetics	
	SW7446	SW	
	SW7446A	SW	
	TL7446	Telefunken	
	SN5446A	† TI	
	SN54246	† TI	
	SN7446A	TI	130
	SN74246	TI	
BCD to 7-Segment Decoder/Driver for gas discharge displays			
	384A/C	Teledyne S	
	384B/M	† Teledyne S	
BCD to 7-Segment Decoder/Driver for lamps and relays			
	CD2500	RCA	
	CD2501	RCA	
	CD2502	RCA	
	CD2503	RCA	
BCD to 7-Segment Latch/Decoder/Driver (CMOS with Bipolar Output)			140
	F4511BC	Fairchild	
	F4511BM	† Fairchild	
	SIL4511B	† Mitel	
	SIL4511BE	Mitel	
	MC14511BA	† Motorola	
	MC14511BC	Motorola	
	CD4511BC	National	
	CD4511BM	† National	
	CD4511B	† RCA	
	CD4511BE	RCA	150
	SCL4511B	† SSS	
	SCL4511BE	SSS	
	CM4511B	† Solitron	
	CM4511BE	Solitron	
	TF4511A/B	† TI	
	TP4511A/B	TI	
BCD to 7-Segment Latch/Decoder/Driver, for Liquid Crystal Displays			
	MC14543BA	† Motorola	
	MC14543BC	Motorola	
BCD to 7-Segment Latch/Decoder/Driver (Strobed Latch), for Liquid Crystal Displays			160
	SIL4056B	† Mitel	
	SIL4056BE	Mitel	
	CD4056B	† RCA	
	CD4056BE	RCA	
BCD to 7-Segment Decoder/Driver, for Liquid Crystal Displays			
	SIL4055B	† Mitel	
	SIL4055BE	Mitel	
	CD4055B	† RCA	
	CD4055BE	RCA	

† Military Temperature Range (−55°C to 125°C) * Typical Values

Bold face indicates additional data is provided on the page noted.

INTERFACE—Display Drivers (Cont'd)

Function	Device	Source	Line
Display Drivers (Cont'd)			
4-Digit Liquid Crystal Display Driver			
	SCL5424	SSS	
	SCL5441	SSS	
4-Segment Liquid Crystal Display Driver			
	CD4054B	† RCA	
	CD4054BE	RCA	
Hex High Voltage Indicator Driver Open Collector (to 55v)			
	HD536	Harris	
Hex TTL to Led Bulb Driver, with Latch			
	DS8859	National	
	DS8869	National	
7 Digit/Segment MOS to Flourescent Display Driver			
	XR2271	Exar	10
3-Digit Gas Discharge Display Anode Driver			
	MC3495	Motorola	
	MC3496	Motorola	
4-Digit Gas Discharge Display Anode Driver			
	UDN-6144A	Sprague	
5-Digit Gas Discharge Display Anode Driver			
	UHP-490	Sprague	
6-Digit Gas Discharge Display Anode Driver			
	ITT512	ITT	
	DS7891	† National	
	DS8891	National	
	UDN-6164A	Sprague	
	UHP-491	Sprague	
	UHP-495	Sprague	20
	SN75481	TI	
7-Digit Gas Discharge Display Anode Driver			
	MC3490	Motorola	
	MC3494	Motorola	
8-Digit Gas Discharge Display Anode Driver			
	DS7887	† National	
	DS8887	National	
	DS7897	† National	
	DS8897	National	
	UDN-6184A	Sprague	
9-Digit Gas Discharge Display Anode Driver			
	NE585	Signetics	
10-Digit Gas Discharge Display Anode Driver			
	ITT504	ITT	30
5-Segment Gas Discharge Display Cathode Driver			
	UHP-480	Sprague	
7-Segment Gas Discharge Display Cathode Driver			
	DS7885	† National	
	DS8885	National	
	UHP-481	Sprague	
7-Segment Gas Discharge Display Cathode Driver, with BCD Decoder			
	DS7880	† National	
	DS8880	National	
	DS8884A	National	
	DM8880	Signetics	
	SN75480	TI	40
8-Segment Gas Discharge Display Cathode Driver			
	ITT505	ITT	
	MC3491	Motorola	
	DS7889	† National	
	DS8889	National	
	UDN-7183A	Sprague	
	UDN-7186A	Sprague	
	UDN-7184A	Sprague	
	UHP-482	Sprague	
9-Segment (Panaplex) Display Cathode Driver			
	NE584	Signetics	50
4-Digit CMOS to LED Cathode Driver			
	MCC1486	Motorola	
	MCC1487	Motorola	
	DS8650	National	
	DS8658	National	
7-Segment CMOS to LED Driver			
	DS8651	National	
	DS8659	National	
6-Digit MOS to LED Cathode Driver			
	9664C	Fairchild	
	9664AC	Fairchild	
	9664BC	Fairchild	
	75492C	Fairchild	60
	75492AC	Fairchild	
	75492BC	Fairchild	
	ITT492	ITT	
	ITT500	ITT	
	ITT502	ITT	
	ITT506	ITT	
	ITT510	ITT	
	LS1060	Lithic Sys.	
	LBC1060	Litronix	
	MC75492	Motorola	70
	DS75492	National	
	DS75494	National	
	DS8870	National	
	DS8877	National	
	DS8892	National	
	NE582	Signetics	
	SN75486	† TI	
	SN75492	TI	
	SN75494	TI	
7-Digit MOS to LED Cathode Driver			
	ITT546A	ITT	80
	DS8844	National	
	SN75497	TI	
7-Digit MOS TO LED Cathode Driver, with low battery indicator			
	DS8866	National	
	DS8977	National	
8-Digit MOS to LED Cathode Driver			
	HD2903	Hitachi	
	ITT508	ITT	
	ITT514	ITT	
	ITT525	ITT	
	LBC1050	Litronix	90
	DS8863	National	
	DS8865	National	
	DS8871	National	
	DS8963	National	
8-Digit LED Driver (for use with G.I. C550-554 Calculator Series)			
	ITT7103	ITT	
9-Digit MOS to LED Cathode Driver			
	ITT526	ITT	
	ITT548	ITT	
	ITT558	ITT	100
	DS8855	National	
	DS8872	National	
	DS8973	National	
	DS8974	National	
	DS8976	National	
	SN75498	TI	
9-Digit MOS to LED Cathode Driver, with low battery indicator			
	DS8864	National	
	DS8873	National	
9-Digit MOS to LED Cathode Driver with shift register decoding			110
	DS8874	National	
	DS8876	National	
	DS8879	National	
12-Digit MOS to LED Cathode Driver (for National Calculators)			
	DS8868	National	
4-Segment MOS to LED Anode Driver			
	75491C	Fairchild	
	75491AC	Fairchild	
	75491BC	Fairchild	
	ITT491	ITT	
	ITT501	ITT	120
	ITT503	ITT	
	ITT507	ITT	
	ITT511	ITT	
	ITT517	ITT	
	ITT518	ITT	
	ITT522	ITT	
	ITT523	ITT	
	MC75491	Motorola	
	DS7895	† National	
	DS8895	† National	130
	DS75491	National	
	DS75493	National	
	SN75491	TI	
	SN75493	TI	
5-Segment MOS to LED Anode Driver			
	DS8861	National	
8-Segment MOS to LED Anode Driver			
	HD2902	Hitachi	
	ITT509	ITT	
	LBC1070	Litronix	
	LBC1071	Litronix	
	MC676	Motorola	140
	DS8867	National	
	SN75487	TI	
Bargraph LED Display Driver			
	UAA170	Siemens	
	UAA180	Siemens	

† Military Temperature Range (−55°C to 125°C)

* Typical Values

INTERFACE—Display Drivers (Cont'd)

Function	Device	Source	Line
Display Drivers (Cont'd)			
BCD-To-Decimal Decoder/Driver (Nixie Driver)			
	5441	† Fairchild	
	7441	Fairchild	
	HD2518	Hitachi	
	ITT7441	ITT	
	MC5441	† Motorola	
	MC676	Motorola	
	MC7441	Motorola	
	DM5441A	† National	
	DM7441A	National	10
	H158	SGS	
	382A/C	Teledyne S	
	382B/M	† Teledyne S	
BCD-To-Decimal Decoder/Driver with Blanking (for cold cathode indicator tubes)			
	74141	Fairchild	
	HD2558	Hitachi	
	ITT54141	† ITT	
	ITT74141	ITT	
	DM54141	† National	
	DM74141	National	20
	TL74141	Telefunken	
	SN74141	TI	
BCD-To-Decimal Decoder/Driver (for lamps)			
	ITT380-1	† ITT	
	ITT380-5	ITT	
	380A/C	Teledyne S	
	380B/M	† Teledyne S	
	381A/C	Teledyne S	
	381B/M	† Teledyne S	
Lamp Driver; See Interface-Display Drivers, and various high current drivers under Interface-Memory and Peripheral Drivers			30
Lamp Drivers (to 90v, 1.5a)			
	S55V01	† **Siliconix (506)**	
	S55V02	† **Siliconix (506)**	
	S55V11	† **Siliconix (506)**	
	S55V12	† **Siliconix (506)**	
	S55V21	† **Siliconix (506)**	
	S55V22	† **Siliconix (506)**	
	S75V01	**Siliconix (506)**	
	S75V02	**Siliconix (506)**	
	S75V11	**Siliconix (506)**	
	S75V12	**Siliconix (506)**	40
	S75V21	**Siliconix (506)**	
	S75V22	**Siliconix (506)**	
Lamp Driver			
	CSR301	Teledyne C	
4-Channel Incandescent Lamp Driver			
	CLD4	Teledyne C	

Function	Device	Source	Line
Display Drivers			

Function	Device	Source	Line
Display Drivers			

† Military Temperature Range (−55°C to 125°C)

* Typical Values

Bold face indicates additional data is provided on the page noted.

INTERFACE—Error Checking Circuits, Keyboard Encoder-Decoders

Function	Max. Serial Data Rate MHz	Supply Voltage	Device	Source
Error Checking Circuits				
CRCC Generator	10	5	9401C	Fairchild
	10	5	9401M	† Fairchild
	3	5	MC8500	Motorola
	10	60ma, 5v	8X01	Signetics
Deskew-Queue Register	3*	5	MC8520	Motorola
	10*	200ma	8X03	Signetics
		200ma	8X04	Signetics
Error Detection/Correction Circuit (EGL)	—	-5.2	MC10163	Motorola
	—	-5.2	MC10193	Motorola
Error Pattern Register	3	5	MC8501	Motorola
LRCC Data Register	3	5	MC8502	Motorola
Single Error Hamming Code Detector and Generator	—	5	MC4041	Motorola
Polynominal Generator	4*	5	MC8506	Motorola
Universal Polynomial Generator	3.5*	5	MC8503	Motorola
Universal Polynomial 4 Bit Generator	17*	5	MC8504	Motorola

No. of Keys	No. of Output Bits	Code	Max. Clock Rate KHz	Comments	Supply Voltage	Device	Source
Keyboard Encoder-Decoders							
16	4	1 of 16		Strobe output, Key rollover output	5	HD-0165	Harris
				2 of 8 keyboard to binary encoder, one of four row inputs and column inputs (telephone key pads) give binary output, strobe.	5	MC14419	Motorola
16	—	—	—			HD54C922	† Harris
						HD74C922	Harris
						MM54C922	† National
				2 key rollover, 3 state output		MM74C922	National
20	—	—	—			HD54C923	† Harris
						HD74C923	Harris
						MM54C923	† National
				2 key rollover, 3 state output		MM74C923	National
28	8 plus Parity	Mask, Programmable	50	4 x 8 matrix, N Key rollover, 2 Levels. Independent or expander for MCS1007. Repeat.	-12,5	MCS1008	MOS
64	8 plus Parity	Mask, Programmable	50	Odd Parity, N Key Rollover, 9 x 8 matrix, 4 levels Repeat.	-12,5	MCS1007	MOS
88	8 plus Parity	Mask, Programmable	100	Programmable parity, strobe width, strobe delay. Two key rollover. 8 x 11 matrix, 3 levels.	-12,5	AY5-2376	GI
						KR2376	SMC
90	10	Mask, Programmable	50	Two units give 180 keys. 9 x 10 matrix, N key rollover, 4 levels. Repeat.	-12,5	MCS1009	MOS
	9	Mask, Programmable	200	Programmable strobe width. 9 x 10 matrix. (N or two key rollover. 4 levels. Repeat.	-12,5	MM5740	National
	10	Mask, Programmable	100	9 x 10 matrix, 4 Mode, 2 or N key rollover	-12,5	AY5-3600	GI
						KR3600	SMC
	ARS33/Baudot/Logical Bit Pairing/Typewriter		100	9 x 10 matrix, N key rollover or lockout	-12,5	TMS5001	TI

(Cont'd)

† Military Temperature Range (−55°C to 125°C) * Typical Values

INTERFACE—Error Checking Circuits, Keyboard Encoder-Decoders (Cont'd)

No. of Keys	No. of Output Bits	Code	Max. Clock Rate KHz	Comments	Supply Voltage	Device	Source
Keyboard Encoder-Decoders (Cont'd)							
90		(Cont'd)					
99	10	Mask, Programmable	250	9 x 9 matrix. N key rollover, 4 levels. No repeat.	-12,5	EA2000	EA
						EA2007	EA
				99 Key, 4 Mode Encoder	-12,5	EA2030	EA

† Military Temperature Range (−55°C to 125°C) * Typical Values

Bold face indicates additional data is provided on the page noted.

INTERFACE—Line Circuits

No. Per Device	Output	Party Line	Power Supply	Comments	Device	Source
Line Drivers-Single Ended						
2	±4 to 6v	No	±9 to ±15	RS232, CCITT V.26	9636C	Fairchild
					9636M	† Fairchild
	±6v	No	±12	4 Input; RS232B, C; MIL188	N8T15	Signetics
	±8v	No	±12	RS232C; MIL188; CCITT V.24	55150M	† Fairchild
					75150	Fairchild
					DS75150	National
					RC75150	Raytheon
					RM55150	† Raytheon
					SN75150	TI
	TTL	No	5,12	130 Ohm Twisted Pair	9621C	AMD
					9621M	† AMD
					9621	Fairchild
					9621M	† Fairchild
					RC9621	Raytheon
					RM9621	† Raytheon
	High Current	Yes	5	Emitter Follower Coax/Twisted Pair	8T13C	Fairchild
					8T13M	† Fairchild
					55121M	† Fairchild
					75121	Fairchild
					MC8T13	Motorola
					DS55121	† National
					DS75121	National
					RC8T13	Raytheon
					RM8T13	† Raytheon
					N8T13	Signetics
					S8T13	† Signetics
					SN55121	† TI
					SN75121	TI
				Coax/Twisted Pair; IBM360, 370	8T23C	Fairchild
					8T23M	† Fairchild
					55123M	† Fairchild
					75123	Fairchild
					MC8T23	Motorola
					DS75123	National
					RC8T23	Raytheon
					RM8T23	† Raytheon
					N8T23	Signetics
					SN75123	TI
3	±6v	No	±12	RS232B/C, CCITT, MIL188	9616C	AMD
					9616	Fairchild
					9616E	Fairchild
					9616M	† Fairchild
4	±6 to 9v	No	±9 to ±15	RS232C, CCITT V.24	MC1488	AMD
					XR1488	Exar
					μA1488	Fairchild
					HD1488	Harris
					ITT1488	ITT
					MC1488	Motorola
					DS1488	National
					RC1488	Raytheon
					MC1488	Signetics
					SG1488	Silicon G
					SN75188	TI
	TTL	No	5	Active Pull-Up	AM2614C	AMD
					AM2614M	† AMD

(Cont'd)

† Military Temperature Range (−55°C to 125°C) * Typical Values

INTERFACE—Line Circuits (Cont'd)

No. Per Device	Output	Party Line	Power Supply	Comments	Device	Source
Line Drivers-Single Ended (Cont'd)						
4	TTL	(Cont'd)				
		Yes	5	Three-State	RC8T09	Raytheon
					RM8T09	† Raytheon
					N8T09	Signetics
					S8T09	† Signetics
				2-Input NAND, 80 ma	96101C	Fairchild
					96101M	† Fairchild
				4 Input AND, NAND; Three-State	DM7831	† AMD
					DM8831	AMD
					DS7831	† National
					DS8831	National
				DS7831 w/o V_{CC} Clamp	DS7832	† National
					DS8832	National

No. Per Device	Output	Party Line	Power Supply	Comments	Device	Source
Line-Drivers - Differential						
2	High Current TTL					
		No	5	40 ma, Active Pull-up/Pull-down	9612C	Fairchild
					9612M	† Fairchild
				50 ma, Active Pull-up/Pull-down	9612EC	Fairchild
				40 ma, Open Collector/Active Pull-up	9614C	AMD
					9614M	† AMD
					9614C	Fairchild
					9614M	† Fairchild
					ITT9614-1	† ITT
					ITT9614-5	ITT
					SN55114	† TI
					SN75114	TI
		Yes	5	40 ma, Open Collector/Active Pull-up, ThreeState	SN55113	† TI
					SN75113	TI
		No	5	40 ma, 4 Input AND, NAND	DM7830	† AMD
					DM8830	AMD
					54S140	† Fairchild
					74S140	Fairchild
					HD74S140	Hitachi
					DM74S140	National
					DS7830	† National
					DS8830	National
					DM7830	† Signetics
					DM8830	Signetics
					74S140	Signetics
					SN54S140	† TI
					SN55183	† TI
					SN74S140	TI
					SN75183	TI
		Yes	5	40 ma, 4 Input AND, NAND; Three State	DM7831	† AMD
					DM8831	AMD
					DS7831	† National
					DS8831	National
				DS7831 w/o V_{CC} Clamp	DM7832	† AMD
					DM8832	AMD
					DS7832	† National

(Cont'd)

† Military Temperature Range (−55°C to 125°C) * Typical Values

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INTERFACE—Line Circuits (Cont'd)

No. Per Device	Output	Party Line	Power Supply	Comments	Device	Source
Line-Drivers - Differential (Cont'd)						
2	High Current TTL	Yes	5	(Cont'd)		
					DS8832	National
	High Current CMOS	No	3-15	CMOS 50 ma, 4 Input AND, NAND	MM78C30	† National
					MM88C30	National
	6 ma	Yes	±5	Twisted Pair; Level Shifting	AM55109	† AMD
					AM75109	AMD
					55109M	† Fairchild
					75109C	Fairchild
					ITT55109	† ITT
					ITT75109	ITT
					MC75109	Motorola
					DS55109	† National
					DS75109	National
					RC75109	Raytheon
					RM55109	† Raytheon
					SN55109	† TI
					SN75109	TI
	12ma	Yes	±5	Twisted Pair Level Shifting	AM55110	† AMD
					AM75110	AMD
					55110M	† Fairchild
					75110C	Fairchild
					ITT55110	† ITT
					ITT75110	ITT
					MC75110	Motorola
					DS55110	† National
					DS75110	National
					RM55110	† Raytheon
					RC75110	Raytheon
					SN55110	† TI
					SN75110	TI
	24 ma	Yes	±5	Higher current 75110	55112M	† Fairchild
					75112C	Fairchild
					SN75112	TI
	±20 ma	Yes	-6,5	Push-Pull Output	MC75113	Motorola
3	2 ma	Yes	5	Constant Current	HD245	† Harris
					HD545	Harris
4	11 ma High Current TTL	Yes	±5	Quad 75110	MC3453	Motorola
		No	5	50 ohm lines	74128	Signetics
					SN74128	TI
				75 ohm lines	54128	† Signetics
					SN54128	† TI
		Yes	5	Three-State	DS1688	† National
					DS3688	National
					8T100	Signetics
					8T101	Signetics
	High Current CMOS	No	3-15	CMOS, 25 ma	MM78C29	† National
					MM88C29	National
	—	Yes	5	RS-422;RS-423	MC3487	Motorola

See also Drivers under digital logic families

† Military Temperature Range (−55°C to 125°C) * Typical Values

INTERFACE—Line Circuits (Cont'd)

No. Per Device	Receiver Input Threshold	Common Mode Voltage	Supply Voltage	Comments	Device	Source
Line Receivers - Single Ended						
2						
	Ref ±0.1v		5	Ext. Reference Adjustable from 1.5 to 3.5v	MC75140	Motorola
					SN75140	TI
				Ext. Ref. Adj. 1.5 to 3.5v with optional iernal 2.5v Reference	SN55142	† TI
					SN75142	TI
	0.4 to 2.4	±15	5	Differential Input, Single Ended Data	AM2615C	AMD
					AM2615M	† AMD
	±2.0		5	RS232B	DS7822	† National
					DS8822	National
3	0.7 to 1.7		5	Hysteresis, IBM 360/370	8T24C	Fairchild
					8T24M	† Fairchild
					55124M	Fairchild
					75124C	Fairchild
					MC8T24	Motorola
					DS75124	National
					RC8T24	Raytheon
					RM8T24	† Raytheon
					N8T24	Signetics
					SN75124	TI
	0.75 to 2.25		5	Hysteresis, RS232C, CCITT V.24	9617C	AMD
					9617C	Fairchild
	0.8 to 2.0 v		5	Hysteresis, High-Speed	8T14C	Fairchild
					8T14M	† Fairchild
					55122M	† Fairchild
					75122C	Fairchild
					MC8T14	Motorola
					DS55122	† National
					DS75122	National
					RC8T14	Raytheon
					RM8T14	† Raytheon
					N8T14	Signetics
					S8T14	† Signetics
					SN55122	† TI
					SN75122	TI
4	±3/0.8 to 3		5 or 12	RS232C, Hysteresis, Fail Safe Option	55154M	† Fairchild
					75154C	Fairchild
					DS75154	National
					SN75154	TI
					RM55154	† Raytheon
					RC75154	Raytheon
	0.75 to 1.5v		5	RS232C, Programmable Threshold, Hysteresis	1489	AMD
					μA1489	Fairchild
					HD1489	Harris
					ITT1489	ITT
					MC1489	Motorola
					DS1489	National
					RC1489	Raytheon
					MC1489	Signetics
					SG1489	Silicon G

(Cont'd)

† Military Temperature Range (−55°C to 125°C) * Typical Values

INTERFACE—Line Circuits (Cont'd)

No. Per Device	Receiver Input Threshold	Common Mode Voltage	Supply Voltage	Comments	Device	Source
Line Receivers - Single Ended (Cont'd)						
4	0.75 to 1.5v	(Cont'd)			SN75189	TI
	0.75 to 2.25		5	RS232C, Programmable Threshold, Hysteresis	1489A XR1489A μA1489A ITT1489A HD1489A MC1489A DS1489A RC1489A MC1489A SG1489A SN75189A	AMD Exar Fairchild ITT Harris Motorola National Raytheon Signetics Silicon G TI
	0.97 to 2.65		5	Hysteresis, 120 Ohm System	DS7836	† National
	1.05 to 2.5		5	Hysteresis, 120 Ohm System	DS8836	National
	1.2 to 1.8		5	120 Ohm System, No Hysteresis, NOR Input	DS7640	† National
	1.3 to 1.7		5	120 Ohm System, No Hysteresis, NOR Input	DS8640	National
	1.5 to 2.0		5	120 Ohm System, Hysteresis, NOR Input	N8T380	Signetics
	1.7		5	No Hysteresis, NOR Input	96106	Fairchild
	5 to 7.5		15	Hysteresis, Interface to CMOS	367A 367M	Teledyne S † Teledyne S
				Hysteresis, Open Collector, Interface to CMOS	368A 368M	Teledyne S † Teledyne S
	5.5 to 8		12	Hysteresis, Interface to CMOS	367B 367C	Teledyne S † Teledyne S
				Hysteresis, Open Collector, Interface to CMOS	368B 368C	† Teledyne S Teledyne S
6	0.97 to 2.65		5	Hysteresis, 120 Ohm System	DS7837	† National
	1.05 to 2.50		5	Hysteresis, 120 Ohm System	MC3437 DS8837 N8T37	Motorola National Signetics
Line Receivers - Differential						
2						
	±0.35/0.3 to 3		5	ADJ. RS232B, C, MIL-188	N8T16	Signetics
	±0.2/0.3	±10/15	5	Twisted Pair, ±15v CMV, Response Control	DS78LS20 DS88LS20	† National National
	±0.2/0.5	±7/15	5	RS232, RS422/3	9637C 9637M	Fairchild † Fairchild
	±0.5/2	±0/15	5,12	±15v CMV	9620M 9620M	† AMD † Fairchild
	±0.5/2	±0/12	5,12	±12 v CMV	9620C 9620C	AMD Fairchild
	±0.3/0.3	±10/15	5	±15v CMV, Response Control	DS78L20 DS78L20 DS88L20	† National † National National
	±0.5/1	±0/15	5	15 v CMV, Response Control	9615C 9615M 9615C	AMD † AMD Fairchild

(Cont'd)

† Military Temperature Range (−55°C to 125°C) * Typical Values

INTERFACE—Line Circuits (Cont'd)

No. Per Device	Receiver Input Threshold	Common Mode Voltage	Supply Voltage	Comments	Device	Source	
Line Receivers - Differential (Cont'd)							
2	±0.5/1	±0/15	5	(Cont'd)			
					9615M	† Fairchild	
					ITT9615-1	† ITT	
					ITT9615-5	ITT	
					SN55115	† TI	
					SN75115	TI	
				Twisted Pair, ±15v CMV, Response Control	DM7820	† AMD	
					DM8820	AMD	
					DS7820	† National	
					DS8820	National	10
					DM7820	† Signetics	
					DM8820	Signetics	
		±5/15	5	±15v CMV	9613C	Fairchild	
					9613M	† Fairchild	
		±3/15	5	Twisted Pair, ±3/15 v CMV, Response Control	DM7820A	† AMD	
					DM8820A	AMD	
					DS7820A	† National	
					DS8820A	National	
					DM7820A	† Signetics	
					DM8820A	Signetics	20
					SN55182	† TI	
					SN75182	TI	
	±0.5/3	±25	±12	Adjusts RS232C/MIL-188, ±25 v CMV, Hysteresis	9627C	Fairchild	
					9627M	† Fairchild	
					SN75152	TI	
	±2	±10	-10,5	130 Ohm Termination	9622C	Fairchild	
					9622M	† Fairchild	
					RC9622	Raytheon	
					RM9622	† Raytheon	
	±0.010	±3	±5	10 mv, MOS Sense Active Pull-up	55207M	† Fairchild	30
					75207C	Fairchild	
					ITT75207	ITT	
					DS75207	**National (475)**	
					75S207	Signetics	
					SN75207	TI	
				10 mv, MOS Sense, Three State	**DS3604**	**National (475)**	
				10 mv, MOS Sense, Open Collector	55208M	† Fairchild	
					75208C	Fairchild	
					ITT75208	ITT	
					DS75208	**National (475)**	40
					75S208	Signetics	
					SN75208	TI	
	±0.025	±3	±5	25 mv, Active Pull-up	55107AM	† Fairchild	
					75107AC	Fairchild	
					ITT55107A	† ITT	
					ITT75107A	ITT	
					MC55107	† Motorola	
					MC75107	Motorola	
					DS55107	**† National (475)**	
					DS75107	**National (475)**	50
					RC75107A	Raytheon	
					RM55107A	† Raytheon	
					75S107	Signetics	
					SN55107A	† TI	
					SN75107A	TI	

(Cont'd)

† Military Temperature Range (−55°C to 125°C) * Typical Values

Bold face indicates additional data is provided on the page noted.

INTERFACE—Line Circuits (Cont'd)

No. Per Device	Receiver Input Threshold	Common Mode Voltage	Supply Voltage	Comments	Device	Source
Line Receivers - Differential (Cont'd)						
2	±0.025	±3	±5	(Cont'd)		
				25 mv, Three State 55107	**DS1603**	**† National (475)**
					DS3603	**National (475)**
				25 mv, Open Collector	55108AM	Fairchild
					75108AC	Fairchild
					ITT55108A	† ITT
					ITT75108A	ITT
					MC55108	† Motorola
					MC75108	Motorola
					DS75108A	**National (475)**
					RC75108A	Raytheon
					RM55108A	† Raytheon
					75S108	Signetics
					SN55108A	† TI
					SN75108A	TI
				55107A w/Diode Protected Input Stage	AM55107B	† AMD
					AM75107B	AMD
					55107BM	† Fairchild
					75107BC	Fairchild
					ITT55107B	† ITT
					ITT75107B	ITT
					DS55107	**† National (475)**
					DS75107	**National (475)**
					SN55107B	† TI
					SN75107B	TI
				55108A w/Diode Protected Input Stage	AM55108B	† AMD
					AM75108B	AMD
					55108BM	† Fairchild
					75108BC	Fairchild
					ITT55108B	† ITT
					ITT75108B	ITT
					DS55108	**† National (475)**
					DS75108	**National (475)**
					SN55108B	† TI
					SN75108B	TI
3	±0.075		±5	100 Ohm Twisted Pair, Shielded	HD248	† Harris
					HD548	Harris
	±1.5 ma		±5	100 Ohm Twisted Pair, Shielded	HD246	† Harris
					HD249	† Harris
					HD546	Harris
					HD549	Harris
4	±0.025	±3	±5	Four 75107, Active Pull-Up	MC3450	Motorola
					DS3650	National
				Four 75108, Open Collector	MC3452	Motorola
					DS3652	National
	±0.2	±3	5	Three-state, RS422/423	MC3486	Motorola
		±15	5	50 mv Hysteresis	DS1689	† National
					DS3689	National
					DS1690	† National
					DS3690	National
					DS3651	**National (489)**
		±15	5	Three State	N8T110	Signetics
					N8T111	Signetics

See also Receivers-listed under Digital-ECL and Digital-HNIL/HTL

† Military Temperature Range (−55°C to 125°C) * Typical Values

INTERFACE—Line Circuits (Cont'd)

No. Per Device	Receiver Input Threshold	Common Mode Voltage	Supply Voltage	Comments	Device	Source	
Line Receivers - Differential (Cont'd)							
See also Receivers-listed under Digital-ECL and Digital-HNIL/HTL							

No. Per Device	Receiver Input Threshold	Output	Supply Voltage	Comments	Device	Source	
Line Transceivers - Single Ended							
2	MOS/TTL	MOS/TTL	5	Transceiver/Port Controller	N8T30	Signetics	
4	0.6 to 2.0	TTL	5	General Purpose Interface Bus, Open Collector, for MOS input	MC3446	Motorola	
	0.8 to 2.0	TTL	5	General Purpose Interface Bus, Open Collector, 100 ma output	MC3440	Motorola	
					MC3441	Motorola	
					MC3443	Motorola	
					DS7641	† National	
					DS8641	National	10
				General Purpose Bus, Open Collector, 100 ma,or 50 ohm system	DS8642	National	
				Three-State	N8T26	AMD	
					S8T26	† AMD	
					9626	Fairchild	
					MC6880	Motorola	
					MC8T26	Motorola	
					N8T26A	Signetics	
					9628	Fairchild	
					MC6889	Motorola	
					MC8T28	Motorola	20
					N8T28	Signetics	
	0.97 to 2.65	TTL	5	Open Collector, 1 v Hysteresis	DS7838	† National	
	1.05 to 2.50	TTL	5	Open Collector, 1 v Hysteresis	MC3438	Motorola	
					DS8838	National	
					N8T38	Signetics	
	1.0 to 2.45	TTL	5	Open Collector, Hysteresis	AM26S12AM	† AMD	
					AM26S12AC	AMD	
	1.2 to 2.2	TTL	5	Open Collector, Hysteresis	AM26S12M	† AMD	
					AM26S12C	AMD	
	1.5 to 3.2	TTL	5	Open Collector, 100 ma output	SG55138	† Silicon G	30
					SN55138	† TI	
	1.6 to 2.3	TTL	5	2-Input, Open Collector 100 ma Drivers	AM2905C	AMD	
					AM2905M	† AMD	
				2-Input, Open Collector 100 ma Drivers, Recver has parity generator	AM2906C	AMD	
					AM2906M	† AMD	
				Open Collector, 100 ma output, Receiver has parity generator	AM2907C	AMD	
					AM2907M	† AMD	
	1.6 to 2.4	TTL	5	Open Collector, 100 ma output	AM26S10M	† AMD	
					AM26S11M	† AMD	
					9640M	† Fairchild	40
					9641M	† Fairchild	
				Open Collector, 100 ma, Hysteresis	9642M	† Fairchild	
	1.75 to 2.25	TTL	5	Open Collector, 100 ma output	AM26S10C	AMD	
					AM26S11C	AMD	
					9640C	Fairchild	
					9641C	Fairchild	

(Cont'd)

† Military Temperature Range (−55°C to 125°C)

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INTERFACE—Line Circuits (Cont'd)

No. Per Device	Receiver Input Threshold	Output	Supply Voltage	Comments	Device	Source
Line Transceivers - Single Ended (Cont'd)						
4	1.75 to 2.25	TTL	5	(Cont'd)		
				Open Collector, 100 ma, Hysteresis	9642C	Fairchild
	1.8 to 2.9	TTL	5	Open Collector, 100 ma output	ITT55138	† ITT
					ITT75138	ITT
					SG75138	Silicon G
					SN75138	TI
	1.05 to 2.50	TTL	5	Three-State, T/R Disables, Hysteresis	DS7833	† National
					DS8833	National
				Inverting 7833/8833	DS7835	† National
					DS8835	National
				Three-State, NOR Gate, Transmit Disable, Hysteresis	DS7839	† National
					DS8839	National
				Inverting 7839/8839	DS7834	† National
					DS8834	National
					N8T34	Signetics
8	TTL	TTL	5	Bidirectional Bus Transceiver	**DP8304**	**National (472)**
Line Transceivers - Differential						
1						
	±0.5/±1v	TTL	5	Independent Three-State 55113 Driver and 5511receiver	SN55116	† TI
					SN75116	TI
				Three-State 8 Pin, 40 ma	SN55117	† TI
					SN75117	TI
				Same as 55116 with Three-State receiver	SN55118	† TI
					SN75118	TI
				Same as 55117 with Three-State receiver	SN55119	† TI
					SN75119	TI

† Military Temperature Range (−55°C to 125°C)

INTERFACE—Memory and Peripheral Drivers

Memory & Peripheral Drivers

Function	Device	Source	Line
MOS Dynamic Memory, Address Refresh Logic Circuitry			
	3222	Intel	
	MC8505	Motorola	
MOS Dynamic Memory, 4k Address Multiplexer and Refresh Counter			
	3232	Intel	
	MC3232A	Motorola	
MOS Dynamic Memory, 16k Address Multiplexer and Refresh Counter			
	3242	Intel	
Clock Generator/Oscillator, to 10 MHz, 8:1 Divider, for Microprocessors			10
	ICM7209	† Intersil	
MOS Clock Driver			
	MH0007	† National	
	MH0012	† National	
	MH0007C	National	
	MH0012C	National	
Dual MOS Clock Driver			
	0026	† AMD	
	0026C	AMD	
	0056	† AMD	
	0056C	AMD	
	SH013C	Fairchild	20
	SH013M	† Fairchild	
	9646	Fairchild	
	MMH0026	† Motorola	
	MMH0026C	Motorola	
	MH0009	† National	
	MH0009C	National	
	MH0013	† National	
	MH0013C	National	
	DS0025	**† National (473)**	
	DS0025C	**National (473)**	30
	DS0026	**† National (474)**	
	DS0026C	**National (474)**	
	DS0056	**† National (474)**	
	DS0056C	**National (474)**	
	SN75369	TI	
Dual MOS Clock Driver (for PMOS Memories)			
	IM5013AC	Intersil	
	IM5013AM	† Intersil	
Quad MOS Clock Driver (for PMOS Memories)			
	IM5003AC	Intersil	
	IM5003AM	† Intersil	
Two Phase Oscillator/Clock Driver (for MOS systems)			40
	DS7803	**† National (490)**	
	DS7807	**† National (491)**	
	DS8803	**National (490)**	
	DS8807	**National (491)**	
	DS8813	**National (490)**	
	DS8817	**National (491)**	
Two Phase Oscillator Driver (for CCD Shift Register Memories)			
	MCC233	Micro Comp	
Quad NMOS Memory Driver			
	MC3459	Motorola	
	MC3460	Motorola	50
	DS3644	**National (488)**	

(Cont'd)

Memory & Peripheral Drivers (Cont'd)

Function	Device	Source	Line
	DS3674	**National (488)**	
	DS36144	**National (494)**	
	DS36174	**National (494)**	
Quad MOS Driver (for clock inputs 2416 and 2444 CCD Memories)			
	5244	Intel	
Quad Port Driver, for 5270 RAM			
	DS1640	**† National (477)**	
	DS3640	**National (477)**	
	DS1670	**† National (477)**	60
	DS3670	**National (477)**	
Dual MOS Clock Driver, bootstrapped for single supply systems			
	DS1642	**† National (478)**	
	DS3642	**National (478)**	
	DS1671	**† National (484)**	
	DS3671	**National (484)**	
	DS1672	**† National (478)**	
	DS3672	**National (478)**	
Quad MOS Clock Driver, decodes input address			
	DS3643	**National (487)**	
	DS3673	**National (487)**	70
Quad, MOS Memory Decoder/Clock Driver			
	DS36143	**National (493)**	
	DS36173	**National (493)**	
6-Bit MOS Refresh Counter/Driver			
	DS1646	**† National (480)**	
	DS3646	**National (480)**	
	DS1676	**† National (480)**	
	DS3676	**National (480)**	
Quad TTL to NMOS Memory Driver (for 7001, etc.)			
	MC3466	Motorola	
Quad TTL to NMOS Memory Driver (for 2105, 2107, etc.)			
	9645	Fairchild	
	3245	Intel	80
	5235	Intel	
	MC3245	Motorola	
Dual TTL to MOS Driver (PMOS Memory Interface)			
	9644	Fairchild	
	ITT75361A	ITT	
	MC75361	Motorola	
	DS75361	**National (498)**	
	DS75362	**National (499)**	
	DS75364	**National (500)**	
	MH8805	National	
	75361A	Signetics	90
	SN75361A	TI	
	SN75362	TI	
Dual AND TTL to MOS Driver (NMOS Memory Interface)			
	9643	Fairchild	
	DS75322	**National (496)**	
	SN75322	TI	
	SN75363	TI	
Dual Channel TTL to MOS Memory Interface (for TMS4062, AMS6002, etc.)			
	ITT75370	ITT	
	SN75370	TI	100

Memory & Peripheral Drivers (Cont'd)

Function	Device	Source	Line
Quad NAND TTL to MOS Driver (MOS Memory Interface-1103 clock driver)			
	3207A	Intel	
	3207A-1	Intel	
	ITT3207	ITT	
	ITT75365	ITT	
	MC75365	Motorola	
	DS75365	**National (501)**	
	μPB246	NEC	
	3207A	Signetics	110
	3207A-1	Signetics	
	SN75365	TI	
Quad TTL to MOS Shifter/Driver; Schottky			
	MB8901	Fujitsu	
	MB8902	Fujitsu	
	MB8907	Fujitsu	
Dual 2-input ECL to MOS Level Shifter/Driver			
	MB8909	Fujitsu	
Quad 2-input ECL to TTL Level Shifter/Driver			
	MB8903	Fujitsu	
Dual Channel ECL to MOS Driver (MOS Memory Interface; also ECL to TTL driver)			
	ITT75368	ITT	
	MC75358	Motorola	120
	MC75368	Motorola	
	SN75368	TI	
Dual MOS Logic to MOS Memory Driver			
	SN75364	TI	
Hex Latch/Driver, for MOS Memories			
	DS1645	**† National (479)**	
	DS3645	**National (479)**	
	DS1675	**† National (479)**	
	DS3675	**National (479)**	
Quad MOS Memory I/O Register			
	DS1647	**† National (481)**	
	DS3647	**National (481)**	
	DS1677	**† National (481)**	130
	DS3677	**National (481)**	
	DS16147	**† National (481)**	
	DS36147	**National (481)**	
	DS16177	**† National (481)**	
	DS36177	**National (481)**	
Quad Predriver, Open Collector, 50 ma Sink (for magnetic memories)			
	MC4042	Motorola	
Dual Memory Driver, 400 ma Sink (for magnetic memories)			
	MC4043	Motorola	
Memory Driver Dual, 400 ma Sink/Source, Decode (for magnetic memories)			140
	75324	Fairchild	
	DS3629	**National (486)**	
	DS75324	**National (497)**	
	RC75324	Raytheon	
	RM55324	† Raytheon	
	75324	Signetics	
	SN75324	TI	

† Military Temperature Range (−55°C to 125°C)

* Typical Values

Bold face indicates additional data is provided on the page noted.

INTERFACE—Memory and Peripheral Drivers (Cont'd)

Memory & Peripheral Drivers (Cont'd)

Function	Device	Source	Line
Memory Driver, Quad, 600 ma Sink, Decode			
	55326M	† Fairchild	
	75326C	Fairchild	
	ITT75326	ITT	
	SN55326	† TI	
	SN75326	TI	
Memory Driver, Quad, 600 ma Source, Decode			
	55327M	† Fairchild	
	75327C	Fairchild	
	ITT75327	ITT	
	SN55327	† TI	10
	SN75327	TI	
	SN55328	† TI	
	SN75328	TI	
Memory Driver, Dual 600 ma Sink/Source, Decode			
	SN55325	† AMD	
	SN75325	AMD	
	55325M	† Fairchild	
	75325	Fairchild	
	ITT55325	ITT	
	ITT75325	ITT	
	MC55325	† Motorola	20
	MC75325	Motorola	
	DS55325	**† National (495)**	
	DS75325	**National (495)**	
	RM55325	† Raytheon	
	RC75325	Raytheon	
	55325	† Signetics	
	75325	Signetics	
	SG55325	† Silicon G	
	SG75325	Silicon G	
	SN55325	† TI	30
	SN75325	TI	
Memory Decoder/Driver 8-Channel, (for core)			
	SN55329	† TI	
	SN75329	TI	
Quad Multiplexer/Driver, for MOS systems			
	9647	Fairchild	
	DS1648	**† National (482)**	
	DS3648	**National (482)**	
	DS1678	**† National (482)**	
	DS3678	**National (482)**	
Hex Inverter/MOS Driver, Three-State			
	9648	Fairchild	
	DS1649	**† National (483)**	40
	DS3649	**National (483)**	
	DS1679	**† National (483)**	
	DS3679	**National (483)**	
Hex Inverter/MOS Driver, disable causes logic 1 state			
	DS16149	**† National (492)**	
	DS36149	**National (492)**	
	DS16179	**† National (492)**	
	DS36179	**National (492)**	
Dual AND Driver, HNIL, 250 ma, Open Collector			
	391	Teledyne S	
Dual Peripheral AND Driver			
	55450A/B	† Fairchild	50
	(Cont'd)		

Memory & Peripheral Drivers (Cont'd)

Function	Device	Source	Line
	55451A/B	† Fairchild	
	55460	† Fairchild	
	55461	† Fairchild	
	55470	† Fairchild	
	55471	† Fairchild	
	75450	Fairchild	
	75451	Fairchild	
	75460	Fairchild	
	75461	Fairchild	60
	75470B	Fairchild	
	75471B	Fairchild	
	HD2574	Hitachi	
	HD2575	Hitachi	
	ITT55450	† ITT	
	ITT55460	† ITT	
	ITT75450	ITT	
	ITT75451	ITT	
	ITT75460	ITT	
	ITT75461	ITT	70
	MC75450	Motorola	
	MC75451	Motorola	
	MC75461	Motorola	
	DS55450	† National	
	DS55451	† National	
	DS55460	† National	
	DS55461	† National	
	DS75450	National	
	DS75451	National	
	DS75460	National	80
	DS75461	National	
	RC75450	Raytheon	
	RC75451	Raytheon	
	RM55450	† Raytheon	
	RM55451	† Raytheon	
	75450	Signetics	
	75450A	Signetics	
	75451	Signetics	
	75451A	Signetics	
	SG55450	† Silicon G	90
	SG55451	† Silicon G	
	SG55460	† Silicon G	
	SG55461	† Silicon G	
	SG75450	Silicon G	
	SG75451	Silicon G	
	SG75460	Silicon G	
	SG75461	Silicon G	
	SN55450B	† TI	
	SN55451B	† TI	
	SN55460	† TI	100
	SN55461	† TI	
	SN55470	† TI	
	SN55471	† TI	
	SN75401	TI	
	SN75411	TI	
	SN75430	TI	
	SN75431	TI	
	SN75450B	TI	
	SN75451B	TI	
	SN75460	TI	110
	SN75461	TI	
	SN75470	TI	
	SN75471	TI	

Memory & Peripheral Drivers (Cont'd)

Function	Device	Source	Line
Dual Peripheral AND Driver, to 80v, 300 ma			
	DS1611	† National	
	DS3611	National	
	DS3611	Signetics	
	UDH5711	Signetics	
	UDN-3611	Sprague	
	UDN-5711	Sprague	120
Dual Peripheral AND Driver, for CMOS			
	DS1631	† National	
	DS3631	National	
Dual 4-Input AND Driver, HNIL 250 ma Open Collector			
	390	Teledyne S	
4-Input AND Current Driver (45v, to 1.5A peak)			
	DH0006	† National	
	DH0006C	National	
4-Input AND High Voltage-High Current Driver (4.5v, to 3A peak)			
	DH0008	† National	
	DH0008C	National	
Quad 2-Input AND Driver (to 70v, sinks 300 ma)			
	UDN-5706A	Sprague	130
Quad 2-Input AND Power Driver, Open Collector (to 100v, sinks 250 ma			
	UHC/D-400	† Sprague	
	UHC/D-406	† Sprague	
	UHC/D-500	Sprague	
	UHC/D-506	Sprague	
	UHP-400	Sprague	
	UHP-406	Sprague	
	UHP-500	Sprague	
	UHP-506	Sprague	
Quad 2-Input NAND Driver (to 70v, sinks 300 ma)			
	UDN-5707A	Sprague	140
Dual NAND Driver, HNIL, 250 ma, Open Collector			
	392	Teledyne S	
4-Input NAND High Voltage, High Current Driver (40 to 50v, sinks 150 to 500 ma)			
	SH2001C	Fairchild	
	SH2001M	† Fairchild	
	SH2002C	Fairchild	
	SH2002M	† Fairchild	
	SH2200C	Fairchild	
	SH2200M	† Fairchild	
Dual Peripheral NAND Driver			
	55452A	† Fairchild	
	55462	† Fairchild	150
	55472B	† Fairchild	
	75452	Fairchild	
	75462	Fairchild	
	75472B	Fairchild	
	HD2577	Hitachi	
	ITT75452	ITT	
	ITT75462	ITT	
	MC75452	Motorola	
	MC75462	Motorola	
	DS55452	† National	160
	DS55462	† National	
	DS75452	National	
	(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

* Typical Values

INTERFACE—Memory and Peripheral Drivers (Cont'd)

Memory & Peripheral Drivers (Cont'd)

Function	Device	Source	Line
	DS75462	National	
	RC75452	Raytheon	
	RM55452	† Raytheon	
	75452B	Signetics	
	SG55452	† Silicon G	
	SG55462	† Silicon G	
	SG75452	Silicon G	
	SG75462	Silicon G	
	SN75402	TI	10
	SN75412	TI	
	SN75432	TI	
	SN55452B	† TI	
	SN75452B	TI	
	SN55462	† TI	
	SN75462	TI	
	SN55472	† TI	
	SN75472	TI	
	SN75475	TI	
Dual 4-Input NAND Driver, HNIL, 250 ma Open Collector			20
	395	Teledyne S	
Dual Peripheral NAND Driver, to 80v, 300 ma			
	DS1612	† National	
	DS3612	National	
	DS3612	Signetics	
	UDN5712	Signetics	
	UDN-3612	Sprague	
	UDN-5712	Sprague	
Dual Peripheral NAND Driver, for CMOS			
	DS1632	† National	
	DS3632	National	
4-Input NAND High Voltage, High Current Drivers (40v, 0.15 to 0.25A)			30
	DH0011	† National	
	DH0011C	National	
4-Input NAND High Voltage, High Current Drivers (50, 70 or 100v, 0.25 to 0.5A)			
	DH0016C	National	
	DH0017C	National	
	DH0018C	National	
Quad 2-Input NAND Power Driver, Open Collector (to 100v, sinks 250 ma)			
	UHC/D-407	† Sprague	
	UHC/D-408	† Sprague	
	UHC/D-507	† Sprague	40
	UHC/D-508	† Sprague	
	UHP-407	Sprague	
	UHP-408	Sprague	
	UHP-507	Sprague	
	UHP-508	Sprague	
Power Peripheral Driver/Logic Switch (to 90v, 1.5a, relay, solenoid, and hammer driver)			
	S55V01	**† Siliconix (506)**	
	S55V02	**† Siliconix (506)**	
	S55V11	**† Siliconix (506)**	
	S55V12	**† Siliconix (506)**	50
	S55V21	**† Siliconix (506)**	
	S55V22	**† Siliconix (506)**	
	S75V01	**Siliconix (506)**	
	S75V02	**Siliconix (506)**	

(Cont'd)

Memory & Peripheral Drivers (Cont'd)

Function	Device	Source	Line
	S75V11	**Siliconix (506)**	
	S75V12	**Siliconix (506)**	
	S75V21	**Siliconix (506)**	
	S75V22	**Siliconix (506)**	
Relay Driver (to 70v, 500 ma)			
	CSR301	Teledyne C	60
Relay Driver, to 65v, sinks 300 ma, OR Input for 48v telephone relays			
	DS1686	† National	
	DS1687	† National	
	DS3686	National	
	DS3687	National	
Dual Relay Driver (to 60v, sinks 1a)			
	831	Beckman	
Dual OR Driver, HNIL, 250 ma, Open Collector			
	393	Teledyne S	
Dual Peripheral OR Driver			
	55453A/B	† Fairchild	
	55463	† Fairchild	
	55473B	† Fairchild	70
	75453	Fairchild	
	75463	Fairchild	
	75473B	Fairchild	
	55453	† Hitachi	
	55463	Hitachi	
	75453	Hitachi	
	75463	Hitachi	
	ITT5453	ITT	
	ITT75463	ITT	
	MC75453	Motorola	80
	MC75463	Motorola	
	DS55453	† National	
	DS55463	† National	
	DS75453	National	
	DS75463	National	
	RC75453	Raytheon	
	RM55453	† Raytheon	
	75453B	Signetics	
	SG55453	Silicon G	
	SG55463	Silicon G	90
	SG75453	Silicon G	
	SG75463	Silicon G	
	SN75433	TI	
	SN55453B	† TI	
	SN55463	† TI	
	SN55473	† TI	
	SN75403	TI	
	SN75413	TI	
	SN75453B	TI	
	SN75463	TI	100
	SN75473	TI	
Dual Peripheral OR Driver, to 80v, 300 ma			
	DS1613	† National	
	DS3613	Signetics	
	DS3613	National	
	UDN5713	Signetics	
	UDN-3613	Sprague	
	UDN-5713	Sprague	

Memory & Peripheral Drivers (Cont'd)

Function	Device	Source	Line
Dual Peripheral OR Driver, for CMOS			
	DS1633	† National	
	DS3633	National	110
Quad 2-Input OR Driver (to 70v, sinks 300 ma)			
	UDN-5703A	Sprague	
Quad 2-Input OR Power Driver, Open Collector (to 100v, sinks 250 ma)			
	UHC/D-402	† Sprague	
	UHC/D-403	† Sprague	
	UHC/D-502	Sprague	
	UHC/D-503	Sprague	
	UHP-402	Sprague	
	UHP-403	Sprague	
	UHP-502	Sprague	
	UHP-503	Sprague	120
Dual NOR Driver, HNIL, 250 ma, Open Collector			
	394	Teledyne S	
Dual Peripheral NOR Driver			
	55454A/B	† Fairchild	
	55464	† Fairchild	
	55474	† Fairchild	
	75454	Fairchild	
	75464	Fairchild	
	75474B	Fairchild	
	HD2579	Hitachi	
	ITT75454	ITT	
	ITT75464	ITT	130
	MC75454	Motorola	
	MC75464	Motorola	
	DS55454	† National	
	DS55464	† National	
	DS75454	National	
	DS75464	National	
	RC75454	Raytheon	
	RM55454	† Raytheon	
	75454B	Signetics	
	SG55454	† Silicon G	140
	SG55464	† Silicon G	
	SG75454	Silicon G	
	SG75464	Silicon G	
	SN75434	TI	
	SN55454B	† TI	
	SN55464	† TI	
	SN75474	† TI	
	SN75404	TI	
	SN75414	TI	
	SN75454B	TI	150
	SN75464	TI	
	SN75474	TI	
Dual Peripheral NOR Driver, to 80v, 300 ma			
	DS1614	† National	
	DS3614	National	
	DS3614	Signetics	
	UDN5714	Signetics	
	UDN-3614	Sprague	
	UDN-5714	Sprague	
Dual Peripheral NOR Driver, for CMOS			
	DS1634	† National	
	DS3634	National	160

† Military Temperature Range (−55°C to 125°C) * Typical Values

Bold face indicates additional data is provided on the page noted.

INTERFACE— Memory & Peripheral Drivers (Cont'd) Sense Amplifiers

Function	Device	Source	Line
Memory & Peripheral Drivers (Cont'd)			
Quintuple High Voltage Interface (Outputs can accept high negative voltages in 'off' state)	SP1404	Plessey	
Quad 2-Input NOR Driver (to 70v, sinks 300 ma)	UDN-5733A	Sprague	
Quad 2-Input NOR Power Driver, Open Collector (to 100v, sinks 250 ma	UHC/D-432	† Sprague	
	UHC/D-433	† Sprague	
	UHC/D-532	† Sprague	
	UHC/D-533	† Sprague	
	UHP-432	Sprague	10
	UHP-433	Sprague	
	UHP-532	Sprague	
	UHP-533	Sprague	
Quintuple Driver (to 5v, 200 ma) Open Collector	SP762B	Plessey	
Quintuple Driver (to 12v, 150 ma) Open Collector	SP761B	Plessey	
Quad Darlington Switch (to 50v, 1.5a)	ULN-2064A	Sprague	
	ULN-2074A	Sprague	
Hammer Driver (to 6A-pulsed output)	DH0028C	National	
Hex Universal Driver (400 ma)	NE582	Signetics	
Driver, 7 Channel, CMOS/TTL Input (hammer, lamp, relay driver)	9667	Fairchild	20
	ITT556	ITT	
	ITT656	ITT	
	MC1413	Motorola	
	L203	SGS	
	SG2003	Silicon G	
	SG3853	Silicon G	
	ULN-2003A	Sprague	
	ULN2003	TI	
Driver, 7-Channel, CMOS/PMOS Input (hammer, lamp, relay driver)	9668	Fairchild	30
	MC1416	Motorola	
	ULN-2004A	Sprague	
	ULN2004	TI	
Driver, 7 Channel, MOS/TTL Input (hammer, lamp, relay driver)	9665	Fairchild	
	ITT552	ITT	
	ITT562	ITT	
	MC1411	Motorola	
	L201	SGS	40
	SG2001	Silicon G	
	SG3851	Silicon G	
	ULN-2001A	Sprague	
	ULN2001	TI	
Driver 7 Channel, PMOS Input (hammer, lamp, relay driver)	9666	Fairchild	
	ITT554	ITT	
	ITT654	ITT	
(Cont'd)			

Function	Device	Source	Line
Memory & Peripheral Drivers (Cont'd)			
	MC1412	Motorola	50
	L202	SGS	
	SG2002	Silicon G	
	SG3852	Silicon G	
	ULN-2002A	Sprague	
	ULN2002	TI	
Printer Driver, 7 Channel	FD1021	Hitachi	
Ten Drivers (to 5v, 200 ma) Open Collector	SP765B	Plessey	
Ten Drivers (to 12v, 200 ma) Open Collector	SP763B	Plessey	
	SP764B	Plessey	
Printer Driver, 10 Channel	FD1018	Hitachi	60
Printing Calculator Circuits	DS8654	National	
	DS8655	National	
	DS8656	National	
	DS8692	National	
	DS8693	National	
	DS8694	National	
Sense Amplifiers			
One Channel Sense Amplifier (for core memories)	MC1440	Motorola	
	MC1540	Motorola	
Dual Channel Gated Sense Amplifier (for core memories)	MC1441	Motorola	70
	MC1541	† Motorola	
	CA1541	† RCA	
Dual Core Memory Sense Amplifier, Separate Outputs	5524M	† Fairchild	
	5525M	† Fairchild	
	55224M	† Fairchild	
	55225M	† Fairchild	
	7524C	Fairchild	
	7525C	Fairchild	80
	75224C	Fairchild	
	75225C	Fairchild	
	ITT5524	† ITT	
	ITT5525	† ITT	
	ITT7524	ITT	
	ITT7525	ITT	
	MC5524	† Motorola	
	MC5525	† Motorola	
	MC7524	Motorola	
	MC7525	Motorola	90
	DS5524	† National	
	DS5525	† National	
	DS7524	National	
	DS7525	National	
	7524	Signetics	
	7525	Signetics	
	SG5524	† Silicon G	
	SG5525	† Silicon G	
(Cont'd)			

Function	Device	Source	Line
Sense Amplifiers (Cont'd)			
	SG7524	Silicon G	100
	SG7525	Silicon G	
	SN5524	† TI	
	SN5525	† TI	
	SN7524	TI	
	SN7525	TI	
Dual Core Memory Sense Amplifier, Complemetary Output, Latch Capability	ITT5520	† ITT	
	ITT5521	† ITT	
	ITT7520	ITT	
	ITT7521	ITT	110
	DS5520	† National	
	DS5521	† National	
	DS7520	National	
	DS7521	National	
	7520	Signetics	
	7521	Signetics	
	SG5520	† Silicon G	
	SG5521	† Silicon G	
	SG7520	Silicon G	
	SG7521	Silicon G	120
	SN5520	† TI	
	SN5521	† TI	
	SN7520	TI	
	SN7521	TI	
Dual Core Memory Sense Amplifier, Single Open Collector Output	ITT5522	† ITT	
	ITT5523	† ITT	
	ITT7522	ITT	
	ITT7523	ITT	
	MC5522	† Motorola	130
	MC5523	† Motorola	
	MC7522	Motorola	
	MC7523	Motorola	
	DS5522	† National	
	DS5523	† National	
	DS7522	National	
	DS7523	National	
	7522	Signetics	
	7523	Signetics	
	SG5522	† Silicon G	140
	SG5523	Silicon G	
	SG7522	Silicon G	
	SG7523	Silicon G	
	SN5522	† TI	
	SN5523	† TI	
	SN7522	TI	
	SN7523	TI	
Dual Core Memory Sense Amplifier, Output Register	SN7526	TI	
	SN7527	TI	
Dual Core Memory Sense Amplifier, Separate Outputs, Test Points	5528M	† Fairchild	150
	5529M	† Fairchild	
	7528C	Fairchild	
	7529C	Fairchild	
	ITT5528	† ITT	
	ITT5529	† ITT	
	ITT7528	ITT	
(Cont'd)			

† Military Temperature Range (−55°C to 125°C)

* Typical Values

INTERFACE— Sense Amplifiers (Cont'd)

Function	Device	Source	Line
Sense Amplifiers (Cont'd)			
	ITT7529	ITT	
	MC5528	† Motorola	
	MC5529	† Motorola	
	MC7528	Motorola	
	MC7529	Motorola	
	DS5528	† National	
	DS5529	† National	
	DS7528	National	
	DS7529	National	10
	SG7528	Silicon G	
	SG7529	Silicon G	
	SN5528	† TI	
	SN5529	† TI	
	SN7528	TI	
	SN7529	TI	
Dual Core Memory Sense Amplifier, Separate Inverted Outputs			
	AM55234	† AMD	
	AM55235	† AMD	
	AM75234	AMD	20
	AM75235	AMD	
	55234M	† Fairchild	
	55235M	† Fairchild	
	75234C	Fairchild	
	75235C	Fairchild	
	ITT55234	† ITT	
	ITT75234	ITT	
	ITT55235	† ITT	
	ITT75235	ITT	
	SN55234	† TI	30
	SN55235	† TI	
	SN75234	TI	
	SN75235	TI	
Dual Core Memory Sense Amplifier, Separate Inverted Outputs, Test Points			
	AM55238	† AMD	
	AM75238	AMD	
	55238M	† Fairchild	
	55239M	† Fairchild	
	75238C	Fairchild	
	75239C	Fairchild	40
	SN55238	† TI	
	SN55239	† TI	
	SN75238	TI	
	SN75239	TI	
Dual Core Memory Sense Amplifier, Separate Open Collector Outputs			
	5534M	† Fairchild	
	5535M	† Fairchild	
	55232M	† Fairchild	
	55233M	† Fairchild	
	7534C	Fairchild	50
	7535C	Fairchild	
	75232C	Fairchild	
	75233C	Fairchild	
	ITT5534	† ITT	
	ITT5535	† ITT	
	ITT7534	ITT	
	ITT7535	ITT	
	MC5534	† Motorola	
	MC5535	† Motorola	
	MC7534	Motorola	60
	(Cont'd)		

Function	Device	Source	Line
Sense Amplifiers (Cont'd)			
	MC7535	Motorola	
	DS5534	† National	
	DS5535	† National	
	DS7534	National	
	DS7535	National	
	SG5534	† Silicon G	
	SG5535	† Silicon G	
	SG7534	Silicon G	
	SG7535	Silicon G	70
	SN55232	† TI	
	SN55233	† TI	
	SN75232	TI	
	SN75233	TI	
Dual Core Memory Sense Amplifier, Separate Open Collector Outputs, Test Points			
	5538M	† Fairchild	
	5539M	† Fairchild	
	7538C	Fairchild	
	7539C	Fairchild	
	ITT5538	† ITT	80
	ITT7538	ITT	
	MC5538	† Motorola	
	MC5539	† Motorola	
	MC7538	Motorola	
	MC7539	Motorola	
	DS5538	† National	
	DS5539	† National	
	DS7538	National	
	DS7539	National	
	SG5538	† Silicon G	90
	SG5539	† Silicon G	
	SG7538	Silicon G	
	SG7539	Silicon G	
Dual Sense Amplifier/Data Register (for core memories)			
	ITT3671-1	† ITT	
	ITT3671-5	ITT	
	ITT55236	† ITT	
	ITT75236	ITT	
	ITT55237	† ITT	
	ITT75237	ITT	100
	SN55236	† TI	
	SN55237	† TI	
	SN75236	TI	
	SN75237	TI	
MOS to TTL Level Converter, High Speed, Three-State			
	MC4000	Motorola	
	MC4300	† Motorola	
Dual Sense Amplifier (for MOS Memory or line receiver)			
	LM163	† AMD	
	LM363	AMD	110
	LM363A	AMD	
	75207	Fairchild	
	75208	Fairchild	
	DS3604	**National (475)**	
	DS1603	**† National (475)**	
	DS3603	**National (475)**	
	DS75207	**National (475)**	
	DS75208	**National (475)**	
	75S207	Signetics	
	(Cont'd)		

Function	Device	Source	Line
Sense Amplifiers (Cont'd)			120
	75S208	Signetics	
	SN75207	TI	
	SN75208	TI	
Dual Sense Amplifier (NMOS memories to ECL 10K)			
	MC3461	Motorola	
	SN75261	TI	
Dual MOS to TTL Level Converter, Latch, Three-State (Sense Amp)			
	MC54468	† Motorola	
	MC74468	Motorola	
	DS3625	**National (485)**	130
	DS7802	† National	
	DS7806	† National	
	DS8802	National	
	DS8806	National	
	N8T25	Signetics	
See also Digital-TTL (Translators)			
Quad Sense Amplifier, Three-State			
	MC3430	Motorola	
	MC3431	Motorola	
	MC3432	Motorola	
	MC3433	Motorola	
	DS3651	**National (489)**	140
	DS3653	**National (489)**	
Hex MOS Sense Amplifier (MOS to TTL Converter) Three-State			
	DS1605	**† National (476)**	
	DS1606	**† National (476)**	
	DS1607	**† National (476)**	
	DS1608	**† National (476)**	
	DS3605	**National (476)**	
	DS3606	**National (476)**	
	DS3607	**National (476)**	
	DS3608	**National (476)**	150
Hex MOS Sense Amplifier, Open Collector (for 1103)			
	3208A	Intel	
Hex MOS Sense Amplifiers with Latches, Three-State			
	3408A	Intel	
4-Channel AC Coupled Sense Amplifier (decoded input channel selection)			
	SN55244	† TI	
	SN75244	TI	
4-Input Sense Amplifier (for plated wire or thick/thin film memories)			
	MC1444	Motorola	
	MC1544	† Motorola	160
Dual Digit Driver, Sense Amplifier, for MD8201 RAM			
	MB8912	Fujitsu	
	MB8915	Fujitsu	
Dual Sense Amplifier with Read Strobe, ECL for MB8215 RAM			
	MB8916	Fujitsu	

† Military Temperature Range (−55°C to 125°C) * Typical Values

Bold face indicates additional data is provided on the page noted.

INTERFACE—Transmitters-Receivers

Serial Transmitters-Receivers

Function	Max Serial Data Rate in KHZ	Supply Voltage	Device	Source
(ACIA) Asynchronous Communications Interface Adapter (Links 8-Bit bidirectional data bus to serial asynchronous data communications, including to 6860	50	5	**S6850**	**AMI (400,889,935)**
		5	MC6850	Motorola
Digital Modem (Modulation, demodulation and supervisory control, up to 600bps.)	0.6	5	**S6860**	**AMI (889,940)**
		5	MC6860	Motorola
PSAR (Programmable Synchronous-Asynchronous Receiver) Synchronous/Asynchronous serial to parallel converter with programmable character length and programmable serial data rate.	100	-12,5	PT1472B	Western
	640	-12,±5	MC2259	Motorola
		-12,±5	NC2259	Nitron
		-12,5	PT1472B-01	Western
PSAT (Programmable Synchronous-Asynchronous Transmitter) Synchronous/Asynchronous parallel to serial converter that has programmable character length and programmable serial data rate.	100	-12,5	PT1482B	Western
	200	-12,±5	MC2257	Motorola
		-12,±5	MC2260	Motorola
		-12,±5	NC2257	Nitron
		-12,±5	NC2260	Nitron
	640	-12,5	PT1482B-01	Western
PSART (Programmable Synchronous-Asynchronous Receiver-Transmitter) Serial to parallel and parallel to serial converter that can operate in Full Duplex Mode.	50	5	8251	Intersil
	1000	5,12	3843	Fairchild
UART (Universal Asynchronous Receiver-Transmitter) complete serial to parallel and parallel to serial interface)	1.2	-12,5	10371	Rockwell
	10	-12,±5	**S1757**	**AMI (400)**
	12.5	-12.5	**S1883**	**AMI (400,401)**
	20	-12,5	TR1602	Western
		-12,5	AY6-1013	† GI
	30	5	AY3-1015	GI
		-12,5	AY5-1013	GI
		5 to 14	AY3-1014A	GI
		-12,5	MM5303	National
		-12,5	TR1602-03	Western
	40	-12,5	AY5-1013A	GI
		-12,5	TR1602-09	Western
	50	5	AY5-1014A	GI
		±5,12	μPD369	NEC
		-12,5	TR1602-05	Western
	60	5	TR1863	Western

(Cont'd)

Serial Transmitters-Receivers (Cont'd)

Function	Max Serial Data Rate in KHZ	Supply Voltage	Device	Source
UART (Cont'd)	100	5	CDP1854C	† RCA
		3-12	CDP1854	† RCA
	200	5	HM6402-2	† Harris
		5	HM6402-9	Harris
		5	HM6403-2	† Harris
		5	HM6403-9	Harris
		5	IM6402	Intersil
		5	IM6402M	† Intersil
		5	IM6403	Intersil
		5	IM6403M	† Intersil
		-12,5	TMS6011	TI
	400	5	HM6402A-2	† Harris
		5	HM6402A-9	Harris
		5	HM6403A-2	† Harris
		5	HM6403A-9	Harris
		-12,5	COM2502	SMC
		-12,5	COM2017	SMC
	600	-12,5	COM2502H	SMC
		-12,5	COM2017H	SMC
USRT (Universal Synchronous Receiver-Transmitter) Complete serial to parallel and parallel to serial interface.	250	-12,5	COM2601	SMC
	500	5	**S2350**	**AMI (400,889,945)**
ASTRO (Asynchronous/Synchronous Receiver/Transmitter) to interface serial communications channel with a parallel digital system (i.e. microprocessors)	1000	12,±5	UC1671	Western
Baud Rate Generator (Programmable Divider)			MM5307	National
			COM5016S	SMC
			COM5016T	SMC
			BR1941	Western

† Military Temperature Range (−55°C to 125°C)

Communications Circuits

Part No.	Description	Word Length (Bits)	Max. Clock Freq. (KHz)	Input/ Output	Power Supply (V)	Process	Package
S1757	Asynchronous Receiver/Transmitter	5, 6, 7, 8	160	MOS	-12, ± 5	P-I^2	3M, 1T
S1883	Asynchronous Receiver/Transmitter	5, 6, 7, 8	200	TTL	-12, ± 5	P-I^2	3M, 1T
S2350	Synchronous Receiver/Transmitter	5, 6, 7, 8	500	TTL	+5	N-SiGate	3M, 1T
S2559	Digital Tone Generator	N/A	N/A	TTL-MOS	+3.5 to +13	CMOS	1U
S6850	Asynchronous Receiver/Transmitter	7, 8	800	TTL	+5	N-SiGate	2L, 1W

Touch Control Interface Circuits

Part No.	Description	Power Supply (V)	I/O	Power Dis. (mW)	Process	Package
S9260/61	7-switch Interface	-13.5 to -18	MOS/TTL	200	P-I^2	1C
S9262	14-switch Interface[3]	-13.5 to -18	MOS/TTL	200	P-I^2	1C
S9263/64/65	16-switch Interface	-13.5 to -18	MOS/TTL	200	P-I^2	1T
S9266	32-switch Interface[3]	-13.5 to -18	MOS/TTL	200	P-I^2	1T

TOUCH CONTROL™

THE TOUCHCONTROL CONCEPT

The S9260 series of MOS TouchControl interface circuits permit almost any control panel containing mechanical switches to be easily replaced by a flat-surface capacitive control panel providing superior styling, reliability, ease of cleaning, and safety. Connecting directly to a screened or etched pattern on the panel's reverse side, these MOS circuits provide outputs to drive a variety of logic systems from household appliances to industrial controls. All system functions are then selected by merely touching the flat conductive TouchControl "switch" areas that have been deposited on the panel's front surface in practically any configuration desired.

The S9260, S9261, S9263, S9264, and S9265 circuits provide an individual output for each of up to 16 TouchControl switches. For applications requiring more switches or encoded outputs, refer to AMI's S9262 and S9266, which can interface with up to 32 switches.

TYPICAL APPLICATIONS

- Applicance Control Panels
- Home Entertainment Systems
- Power Tool Controls
- Television Sets
- Automotive Controls
- Telephones
- Games
- Fast Food Waterproof Keyboards
- Moisture Proofing
- Industrial Controllers
- Computer Terminals
- Keyboards
- Instrumentation
- 16 to 1 Multiplexers
- Microprocessor Interface
- Vending Machines
- Cash Registers

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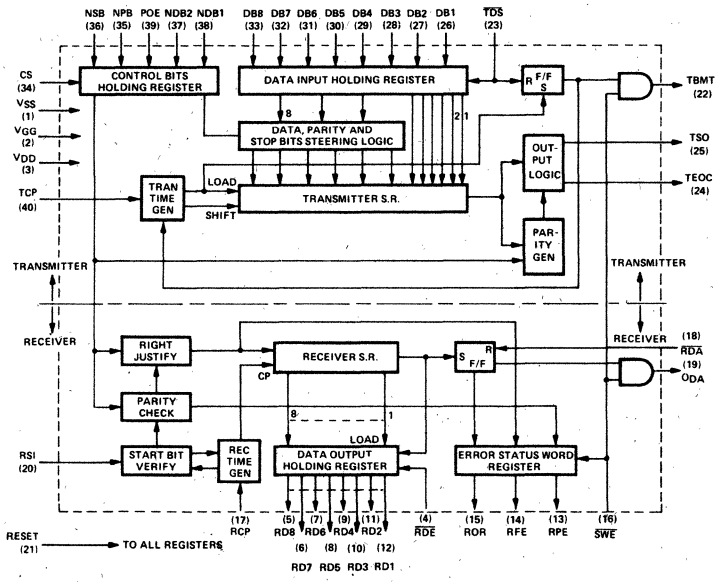
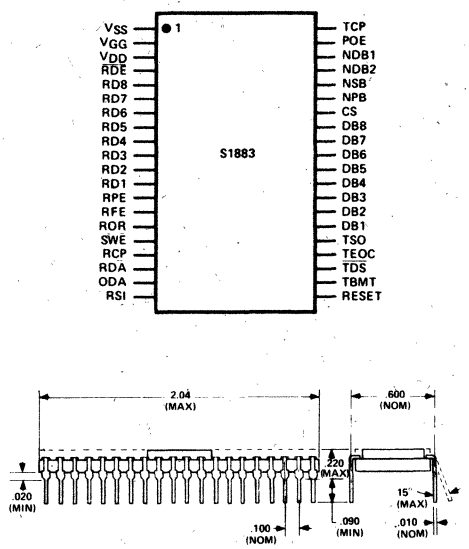
AMERICAN MICROSYSTEMS, INC.

S1883

UART



S1883 BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- 12.5 K Baud Data Rates
- 5-8 Bit Word Length
- Parity Generation/Checking Odd, Even, None
- Framing and Overflow Error Detection
- 1, 1.5, or 2 Stop Bits
- Double Buffered Input/Output
- Independent Transmit/Receive Rates
- Start and Stop Bits Generated and Detected
- Interchangeable with TMS6011, COM2017, TR1602, AY-5-1013
- Tri-State Outputs

FUNCTIONAL DESCRIPTION

The S1883 Universal Asynchronous Receiver Transmitter (UART) is a single chip MOS/LSI device that totally replaces the asynchronous parallel to serial and serial to parallel conversion logic required to interface a word parallel controller or data terminal to a bit serial communication network.

For asynchronous data transmission with a non-contiguous data bit stream, the UART automatically inserts a START bit preceding each character and under program control 1, 1.5, or 2 stop bits at the end of each character. To detect incoming characters in a noisy environment the UART employs a START bit detection network and allows errorless recovery of data with up to 42% distortion.

The UART will transmit or receive data characters of 5, 6, 7, or 8 bit length. Options allow the generation and checking of odd, even parity or no parity. The odd or even parity bit is automatically added to the character length for transmission. The parity bit is removed, checked and an error flag set if incorrectly received.

The data or baud rate at the receiver input and transmitter output are determined independently by external clock inputs. The clock inputs must be 16 times the data rate required at the serial input and output. The independent clocks allow for either half or full duplex operation.

The UART provides a buffer register in both the transmitter and receiver to allow a full character time for responding to a received data ready or transmit data request signal. The UART generates a MARK signal if the transmit register is not loaded with a data character and also indicates an overflow error if two characters are received without a RDA input.

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TYPICAL APPLICATIONS

- Computer Peripherals
- Communication Concentrators
- Integrated Modems
- Industrial Data Transmission
- TTY Terminals
- Time Division Multiplexing

ABSOLUTE MAXIMUM RATINGS

Ambient Temperature Under Bias	0°C to +70°C
Storage Temperature	−65°C to +150°C
Positive Voltage on Any Pin with Respect to V_{SS}	+.3 Volt
Negative Voltage on Any Pin with Respect to V_{SS}	−20.0 Volt

NOTE: Stresses greater than those listed as Maximum Ratings may cause permanent damage to the device. Functional operation of the device at these or any other conditions above those indicated in the operation section of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

DC (STATIC) CHARACTERISTICS

$T_A = 0° - +70°C$, $V_{SS} = +5$ Volt ±5%, $V_{GG} = -12$ Volt ±5%

Symbol	Parameter	Min	Max	Unit	Condition
V_{IH}	Input High Voltage	V_{SS} −1.0	V_{SS} +0.3	Volt	Internal Pull-up
V_{IL}	Input Low Voltage	V_{GG}	0.8	Volt	Resistor Provided
I_{LI}	Input Load Current		−1.2	mamp	V_{IN} = 0 Volt
V_{OH}	Output High Voltage	2.4		Volt	I_{OH} = - 100 uamp
V_{OL}	Output Low Voltage		.4	Volt	I_{OL} = 1.6 mamp
C_{IN}	Input Capacitance		20	pf	$V_{IN} = V_{SS}$
C_{OUT}	Output Capacitance		10	pf	$V_{OUT} = V_{SS}$
I_{SS}	V_{SS} Supply Current		30	mamp	$\overline{SWE} = \overline{RDE} = V_{IL}$
I_{GG}	V_{GG} Supply Current		40	mamp	ITTL Load

AC (DYNAMIC) CHARACTERISTICS

$T_A = 0°C - +70°C$; $V_{SS} = +5$ Volt ±5%; $V_{GG} = -12$ Volt ±5%

Symbol	Parameter	Min	Max	Unit	Condition
TCP, RCP	Clock Frequency	DC	200	KHz	
Input Pulse Widths					
PWTCP	Transmit Clock	2.5		usec	C_L = 20pf
PWRCP	Receive Clock	2.5		usec	1 TTL Load
PWCS	Control Strobe	250		nsec	
PWTDS	Transmit Data Strobe	250		nsec	
PWRST	RESET	1.0		μsec	
PWSWE	Status Word Enable	500		nsec	
PWRDA	Reset Data Available	500		nsec	
PWRDE	Receive Data Enable	250		nsec	
Switching Characteristics					
t_{CDS}	Control Set Up Time	0		nsec	Figure 1
t_{CDH}	Control Hold Time	20		nsec	Figure 1
t_{OE}	Output Enable Time		500	nsec	
t_{OD}	Output Disable Time		500	nsec	

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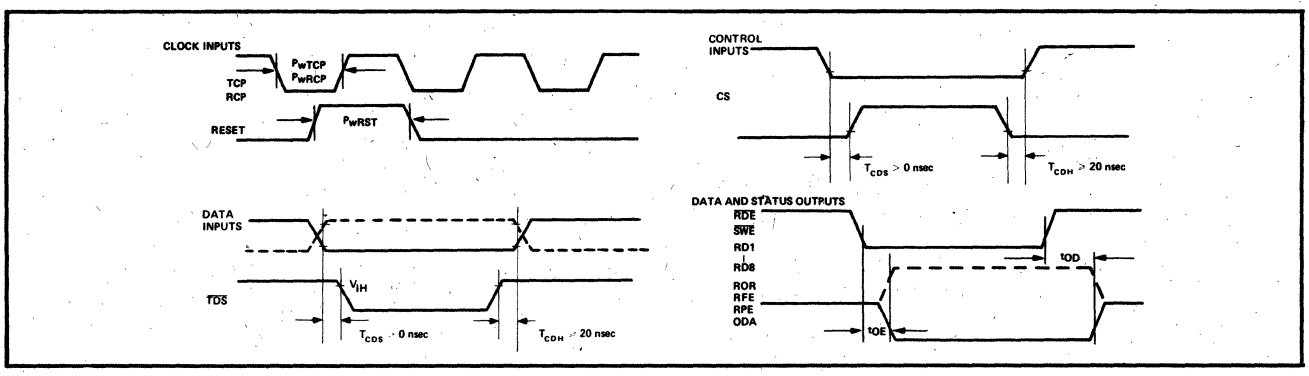
TIMING WAVEFORMS (Figure 1)



PIN DEFINITIONS

Pin	Label	Function
(1)	V_{SS}	+5 Volt ± 5%
(2)	V_{GG}	−12 Volt ± 5%
(3)	V_{DD}	Ground
(21)	RESET	The transmitter status outputs TBMT and TEOC are set to V_{OH} indicating the input transmitter buffer register is empty. The TSO output generates V_{OH} or MARK until a valid data character has been loaded into the transmitter and valid data transmission begins. The receiver status output ODA, is reset to the V_{OL} state.
(38)	NDB1	Number Data Bits/Character
(37)	NDB2	Number Data Bits/Character
(36)	NSB	Number Stop Bits The bit length of each data character and the number of stop bits added to each transmitted character are defined by these three inputs. The character word length does not include the parity bit and is common to both the transmitter and receiver if operating in the full duplex mode.

NSB	NDB2	NDB1	BITS/CHARACTER	STOP BITS
V_{IL}	V_{IL}	V_{IL}	5	1
V_{IL}	V_{IL}	V_{IH}	6	1
V_{IL}	V_{IH}	V_{IL}	7	1
V_{IL}	V_{IH}	V_{IH}	8	1
V_{IH}	V_{IL}	V_{IL}	5	1.5
V_{IH}	V_{IL}	V_{IH}	6	2
V_{IH}	V_{IH}	V_{IL}	7	2
V_{IH}	V_{IH}	V_{IH}	8	2

(35)	NPB	NO PARITY BIT. A V_{IH} eliminates the PARITY bit from being transmitted causing the STOP bit(s) to immediately follow the last data bit. The receiver assumes the bit(s) following the last data bit to be STOP bits. The RPE output is also forced to a V_{OL} condition.
(39)	POE	PARITY ODD/EVEN. If the NPB input is V_{IL}, the parity mode is ODD if POE is V_{IL} and EVEN if POE is V_{IH}. The parity mode is the same for both the transmitter and receiver.
(34)	CS	CONTROL STROBE. A V_{IH} loads POE, NDB1, NDB2, NPB, NSB into the CONTROL HOLDING REGISTER. To load the control inputs for static operation CS can be hard-wired to V_{IH}.
(26) (27) (28) (29) (30)	DB1 DB2 DB3 DB4 DB5	TRANSMITTER DATA BITS. Input data on DB1-DB8 are strobed into the DATA INPUT HOLDING REGISTER by $\overline{TDS}$. Input data is assumed right justified so DB1 is always the least significant bit and is the bit

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Pin	Label	Function
(31) (32) (33)	DB6 DB7 DB8	transmitted following the START bit. For data words less than eight bits, the unused bits are don't care inputs.
(23)	$\overline{TDS}$	TRANSMITTER DATA STROBE. A V_{IL} enters data on the DB1-DB8 inputs into the INPUT HOLDING REGISTER. If the transmitter is in the idle state with both TBMT and TEOC at V_{OH}, the START bit will be generated on the first negative transition of the input clock TCP following the return of $\overline{TDS}$ to a V_{IH} state.
(25)	TSO	TRANSMITTER SERIAL OUTPUT. Data entered on DB1-DB8 are serially transmitted on TSO. A START (SPACE) bit precedes each character. A PARITY bit, if selected, and the correct number of STOP bits follow the last valid data bit. The TSO output is V_{OH} (MARK) when a valid character is not being transmitted.
(22)	TBMT	TRANSMITTER BUFFER EMPTY. A V_{OH} indicates the character in the INPUT HOLDING REGISTER has been transferred into the transmitter and a new character may be loaded into the INPUT HOLDING REGISTER. One complete character time (START BIT, DATA BITS, PARITY BIT, AND STOP BIT(S)) is available to load the next character. If a $\overline{TDS}$ is not generated within the time allotted, the TSO output will go into an idle state of V_{OH} or a MARK condition. TBMT will remain in the tri state mode unless $\overline{SWE}$ is a U_{ZL}.
(24)	TEOC	TRANSMITTER END OF CHARACTER. A V_{OL} to V_{OH} transition indicates the transmission of the character and stop bits have been completed. The V_{OH} is maintained until the leading edge of the next START bit (MARK to SPACE transition) is generated.
(40)	TCP	TRANSMITTER CLOCK PULSE. The transmitter input clock must be 16 times faster than the desired baud rate at TSO.
(17)	RCP	RECEIVER CLOCK PULSE. The receiver input clock must be 16 times the baud rate of data received on RSI.
(20)	RSI	RECEIVER SERIAL INPUT. Serial input data is received on RSI at a baud rate 1/16th the rate of RCP. The V_{IH} to V_{IL} (MARK to SPACE) transition beginning each START bit synchronizes the receiver to the incoming data. Data is assumed to be received least significant bit first.
(12) (11) (10) (9) (8) (7) (6) (5)	RD1 RD2 RD3 RD4 RD5 RD6 RD7 RD8	RECEIVER DATA. Data outputs from the DATA OUTPUT HOLDING REGISTER are active only when $\overline{RDE}$ is a V_{IL}. The eight data outputs are in a tri-state mode if $\overline{RDE}$ is a V_{IH}. Data is presented at the outputs right justified with RDI the least significant bit. For data word lengths less than 8 bits the unused bits will appear as V_{OL}.
(4)	$\overline{RDE}$	RECEIVER DATA ENABLE. A V_{IL} enables data in the DATA OUTPUT HOLDING REGISTER to the RECEIVER DATA output pins. For an output configuration not requiring a tri-state condition for RD1-RD8 the RDE input can be tied directly to ground enabling the data outputs at all times.
(19)	ODA	OUTPUT DATA AVAILABLE. A V_{OH} indicates a complete character has been received and transferred to the DATA OUTPUT HOLDING REGISTER. The ODA output will be in the tri-state mode unless $\overline{SWE}$ is a V_{IL}. For contiguous data inputs on RSI data will remain in the holding register one character time before being lost.
(18)	$\overline{RDA}$	RESET DATA AVAILABLE. A V_{IL} resets the ODA to a V_{OL}. If ODA is not reset by $\overline{RDA}$ the ROR will be set when the next complete character is received and transferred to the DATA OUTPUT HOLDING REGISTER.
(15)	ROR	RECEIVER OVERRUN. A V_{OH} indicates a second character has been received and transferred to the DATA OUTPUT HOLDING REGISTER without an intervening $\overline{RDA}$. If the previously received character has not been unloaded from the register the next character will be loaded and the first character lost. ROR will remain in the tri-state mode unless $\overline{SWE}$ is a V_{IL}.
(14)	RFE	RECEIVER FRAMING ERROR. A V_{OH} indicates a correct STOP bit was not received following the START bit and correct number of data bits. RFE will remain in the tri-state mode unless $\overline{SWE}$ is a V_{IL}.

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Pin	Label	Function
(13)	RPE	RECEIVER PARITY ERROR. A V_{OH} indicates the accumulated parity on the received character does not compare with the parity mode set by POE. RPE will remain in the tri-state mode unless $\overline{SWE}$ is a V_{IL}.
(16)	$\overline{SWE}$	STATUS WORD ENABLE. A V_{IL} enables the status outputs ODA, ROR, RFE, RPE and TBMT on the respective output lines. When $\overline{SWE}$ is V_{IH} all status outputs are in the tri-state mode. For output configurations not requiring a tri-state condition for the status outputs, $\overline{SWE}$ may be tied directly to ground.

APPLICATION DATA

Asynchronous data communications is typified by low data rates, non-contiguous data messages, and a MARK condition on the line between characters. As a result, each data character must be framed for recognition by START and STOP bits. The S1883 UART provides all the logic required to provide a complete full-duplex (transmit and receive simultaneously) asynchronous communication channel for baud rates up to 9600 bps. Included in the S1883 capabilities are; automatic START and STOP bit generation and detection; PARITY generation and detection on variable length characters; tri-state outputs for data and status for data bus configurations, double buffering for less critical timing, and a receiver allowing acceptance of data with up to 42% distortion.

RECEIVER OPERATION

Asynchronous communication line discipline dictates that each character, regardless of width, must be preceded by a START bit. The receiver input logic detects the V_{IH} to V_{IL} (MARK to SPACE) transition on the RSI line that is the leading edge of the START bit. For one half bit time after the leading edge, RSI is sampled for a V_{IL} to insure a proper START bit was present. The following data bits are then clocked into the receiver in the center of each bit period. If RSI returns to the V_{IH} condition before the mid-point of the START bit, the receiver returns to a search for a MARK to SPACE transition.

If at the time of transfer ODA has not been reset by a $\overline{RDA}$, indicating the previous character has not been read, the ROR error flag is set to V_{OH}. The previous data character and status will be lost as the new character is loaded. One full character time is available, assuming contiguous data input at RSI, after ODA is set to read the output character. The data is available at the outputs RD1-RD8 right justified with RD1 the least significant bit. For character widths less than 8 bits the unused outputs are forced to V_{OL}.

For data bus configurations the output data and status are tri-state lines enabled by $\overline{RDE}$ and $\overline{SWE}$ respectively. For polled systems $\overline{SWE}$ can be strobed for detection of ODA and error conditions prior to reading data. For interrupt driven systems $\overline{SWE}$ can be tied directly to ground and ODA used as a data ready interrupt input. A minimum of one character time is available to test the remaining error status bits and input the data character. Typically the same signal can be used for $\overline{RDE}$ and $\overline{RDA}$.

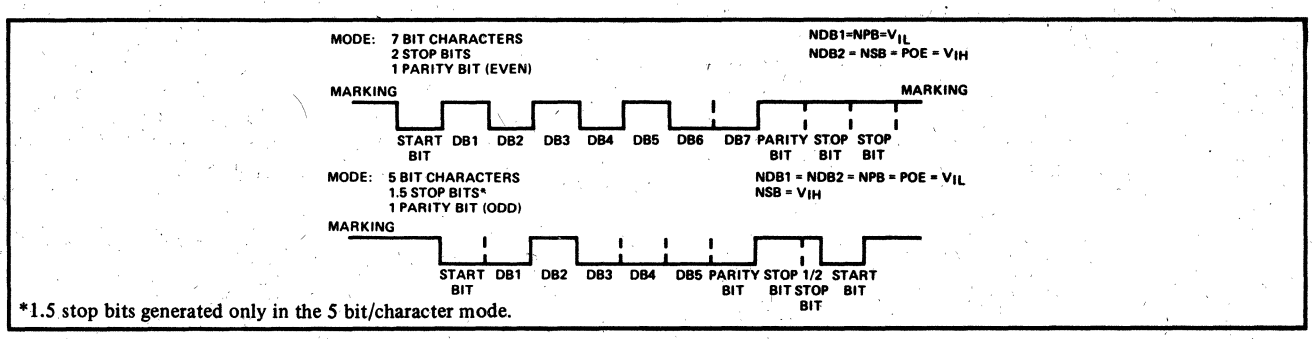
TRANSMITTER OPERATION

The transmit section of the S1883 is reset to a MARK condition with V_{OH} on TSO after receiving a pulse on RESET. Additionally, the transmitter is reset to a character request mode with TBMT and TEOC both at V_{OH}. If the character format is not static, the word length NDB1 and NDB2, parity mode NPB and POE, and number of stop bits NSB should be strobed into the UART with CS.

If both the DATA INPUT HOLDING REGISTER and the TRANSMITTER SHIFT REGISTER are empty the transmitter is in the idle state with TSO, TBMT and TEOC all at V_{OH}. The START bit for a data character loaded with a $\overline{TDS}$ pulse during the idle state is generated at the first negative transition of the TCP following the trailing edge of $\overline{TDS}$. TBMT goes to V_{OL} with the first $\overline{TDS}$. As soon as the character is transferred from the INPUT HOLDING REGISTER to the SHIFT REGISTER, TBMT returns to a V_{OH} and a second character can be loaded. Each character is transmitted with a START bit and 1, 1.5 or 2 stop bits controlled by the respective inputs.

The TEOC is set to V_{OH} after the generation of the last STOP bit indicating the complete character has been transmitted.

TYPICAL DATA FORMAT



*1.5 stop bits generated only in the 5 bit/character mode.

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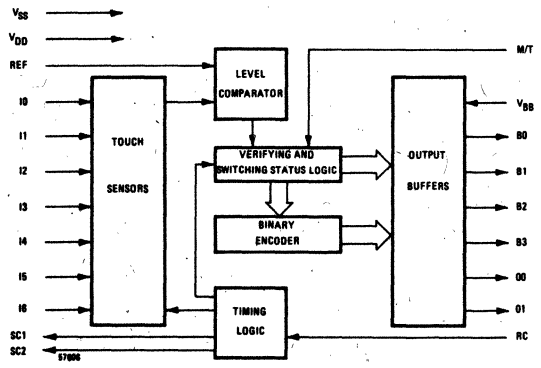
S9262/S9266

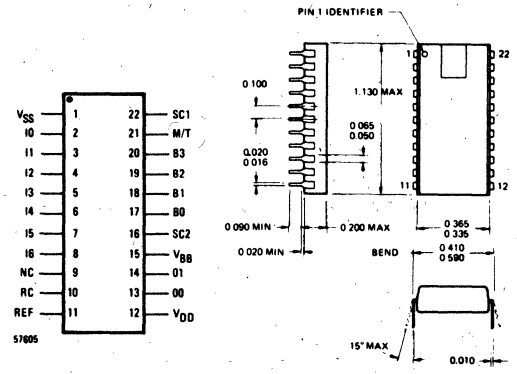
MULTIPLEXED
TOUCHCONTROL INTERFACE

AMERICAN MICROSYSTEMS, INC.

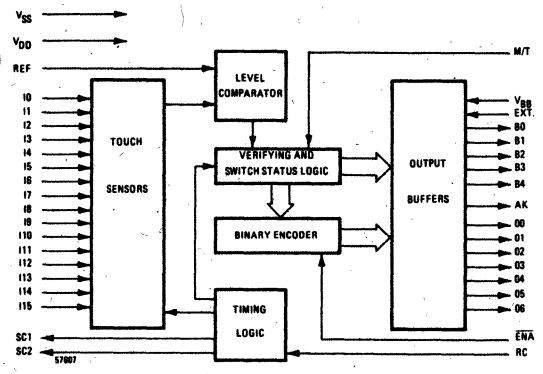
ADVANCED PRODUCT DESCRIPTION



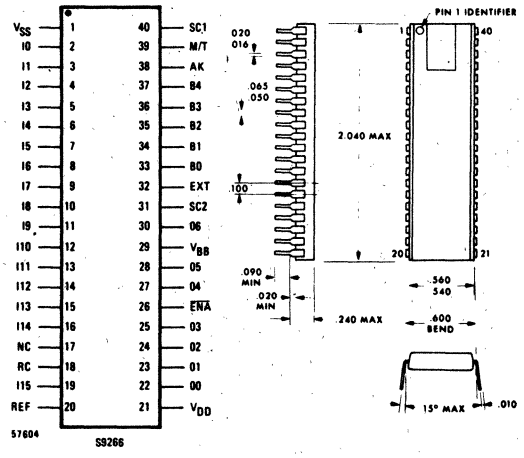
BLOCK DIAGRAM – S9262 (14 SWITCHES)



PIN/PACKAGE CONFIGURATION – S9262



BLOCK DIAGRAM – S9266 (32 SWITCHES)



PIN/PACKAGE CONFIGURATION – S9266

FEATURES

- Simplifies design of Touch-sensitive switches
- Interfaces with up to 32 touch switches
- Eliminates contact noise
- Comparator sensing permits use with wide variety of touch switch configurations
- Binary outputs provided
- Outputs are TTL compatible
- Permits design of totally isolated touch surfaces, facilitating UL approval

FUNCTIONAL DESCRIPTION

Fabricated with P-channel ion implanted MOS/LSI technology, AMI TouchControl integrated circuits* are designed to interface with a variety of touch panel switches and provide a high degree of flexibility in the selection of touch panel materials, layout of touch pad configurations, and design of switching functions. These parts are designed to address an array of TouchControl switches in either a 2 x 7 matrix (S9262) or a 2 x 16 matrix (S9266) to interface with a total of either 14 or 32 switches. The outputs are binary encoded for easy interfacing with microprocessors or TTL, CMOS or MOS logic.

Both momentary and "push on – push off" (toggle) switching operations are available on AMI TouchControl circuits and are electrically selected by the logic level of the M/T input pin. To ensure reliable switch action, a built in delay is incorporated in all circuits requiring a minimum touch time for switch response.

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ABSOLUTE MAXIMUM RATINGS

Voltage on any pin except EXT relative to V_{SS}:	+ 0.3V to - 20V	Operating temperature range:	0°C to + 50°C
Voltage on EXT pin relative to V_{SS}:	+ 0.3V to - 27V	Storage temperature (Ambient)	- 65°C to + 150°C

**For non-multiplexed TouchControl circuits see AMI S9260, S9261, S9263, S9264, S9265*

ELECTRICAL CHARACTERISTICS

($0°C \leq T_A \leq 50°C$; $V_{SS} = 0V$; $V_{DD} = -13.5V$ to $-18.0V$ unless otherwise specified.)

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNITS	CONDITIONS
V_{IL}	Input logic 0 level – all except "I" inputs.	+ 0.3	0	- 1.5	Volts	Note: M/T and $\overline{ENA}$ inputs are internally pulled up to V_{SS}.
V_{IH}	Input logic 1 level – all except "I" inputs.	- 10.0	- 12.0	- 18.0	Volts	
f_{RC}	Internal oscillator frequency measured at RC input.	50		100	kHz	
T_S	Switch delay time	50		200	msec	Frequency measured at RC Input = 50 kHz.
T_{RST}	Time to reset all latches using M/T input.		100		msec	
V_{OL}	Output low voltage.	V_{SS}		- 1.0	Volts	$V_{BB} = V_{SS}$; 10K resistive load to V_{DD}.
V_{OH}	Output high voltage			V_{DD}		
V_{OL}	Output low voltage.	V_{SS}		V_{SS} - 0.5	Volts	$V_{SS} = + 5V$; $V_{BB} = 0V$ $V_{DD} = - 12V$; 2800Ω resistive load to V_{SS}.
V_{OH}	Output high voltage	V_{BB} + 0.4		V_{BB}		
SC1, SC2	Scan clock output.					Max. capacitive loading ≤ 150 pF.
	Output low voltage	V_{SS}		- 1.5		
	Output high voltage.			V_{DD}		

OPERATION

Device operation can be understood by referring to Figure 1, depicting a typical application of the S9266. Each of the 32 pairs of series capacitors labeled S1 – S32 is one touch switch located on a TouchControl panel constructed of glass, printed circuit board, epoxy, or other dielectric material. (For details on touch panel configuration and operation, see the TouchControl application note included in this APD.) In each capacitor pair, the two common plates represent the conductive area on the control panel surface that is to be touched. The other two plates are formed by two conductive surfaces parallel to the touched surface and located directly under it on the reverse side of the panel. Referring again to Figure 1, the S9266 generates a clock signal on output SC1 and a similar signal on output SC2. The SC1 clock output is connected to the common conductors of 16 of the 32 touch switches; the SC2 clock connects to the remaining 16 switches. For each touch switch the clock signal passes through the two series capacitors and is detected in the MOS circuit. When a panel switch surface is touched, the signal level into the chip diminishes, and the on-chip differential amplifier senses the change and performs the appropriate switching function.

I INPUTS

Inputs from the touch switch pads to the TouchControl circuit are labeled I0 through I15 (S9266), or I0 through I6 (S9262). The I inputs in conjunction with SC1 and SC2 outputs form a touch switch matrix of 2 x 16 or 2 x 7, respectively. In both these parts the outputs are binary coded and will be described later.

RC INPUT

A resistor connected to V_{DD} and a capacitor connected to V_{SS} are connected to the RC input pin to establish the on-chip clock frequency that controls the rate of multiplexing and the touch switch delay time. Nominal values for these components are suggested in Figure 1, but they may be varied to change clock frequency over a range of 50kHz to 100 kHz.

REF INPUT

In order to allow flexibility in the choice of TouchControl panel materials, switch layout, and switch size, AMI TouchControl inputs have been designed to detect a differential change rather than an absolute change in level. To obtain a reference level, two resistors are connected to input REF, one connected to input REF, one connected to V_{SS} and the other to V_{DD}.

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V_{BB} SUPPLY

The sources of all output devices (both "O" and "B" outputs) are common and connected to pin V_{BB}. This allows TTL compatibility as shown in Figure 1, as well as the ability to drive higher level signals. For instance, if V_{SS} = 0 volts, V_{DD} = - 16 volts, and V_{BB} = V_{SS}, then active outputs would drive a load connected to V_{DD} towards V_{SS}.

M/T INPUT

The M/T input pin selects the mode of switch operation, either momentary or toggle. Applying V_{SS} to the M/T pin selects momentary operation in which appropriate outputs are active only for the duration of touching a switch. In this mode, no output is active when no switch is touched. A V_{DD} level applied to M/T causes the circuit to operate in the toggle mode for "push-on, push-off" operation. Subsequent activation of the switch will toggle the corresponding output on and off alternately. It should be noted that each input should be cleared to the off state before selecting a new input to obtain meaningful data from the binary outputs. To reset all outputs when the toggle mode is selected, a pulse of V_{SS} level may be applied to the M/T input.

SC1 and SC2 OUTPUTS

The S9262 and S9266 have multiplexed inputs, using 2 x 7 and 2 x 16 matrices, respectively, to provide 14 and 32 input states. Clock signals SC1 and SC2 are used along with the "I" inputs to form these matrices as connected in the schematic of Figure 1.

O OUTPUTS

Each output pin labeled "O" corresponds to an input pin labeled "I". Whenever an input is selected, the output becomes active and will drive an external load toward supply voltage V_{BB}. This is true for momentary operation only; toggle operation is described in the section labeled "MT input." When "O" outputs are not active, they are high impedance open drain.

B AND AK OUTPUTS

The S9262 has four and the S9266 has five outputs labeled "B." These supply a binary code relating to the state of the inputs. Fourteen unique states are available on S9262 and thirty-two on S9266. The output configuration is identical to the "O" outputs. An extra output labeled AK is available on the S9266 and is active whenever any key is selected.

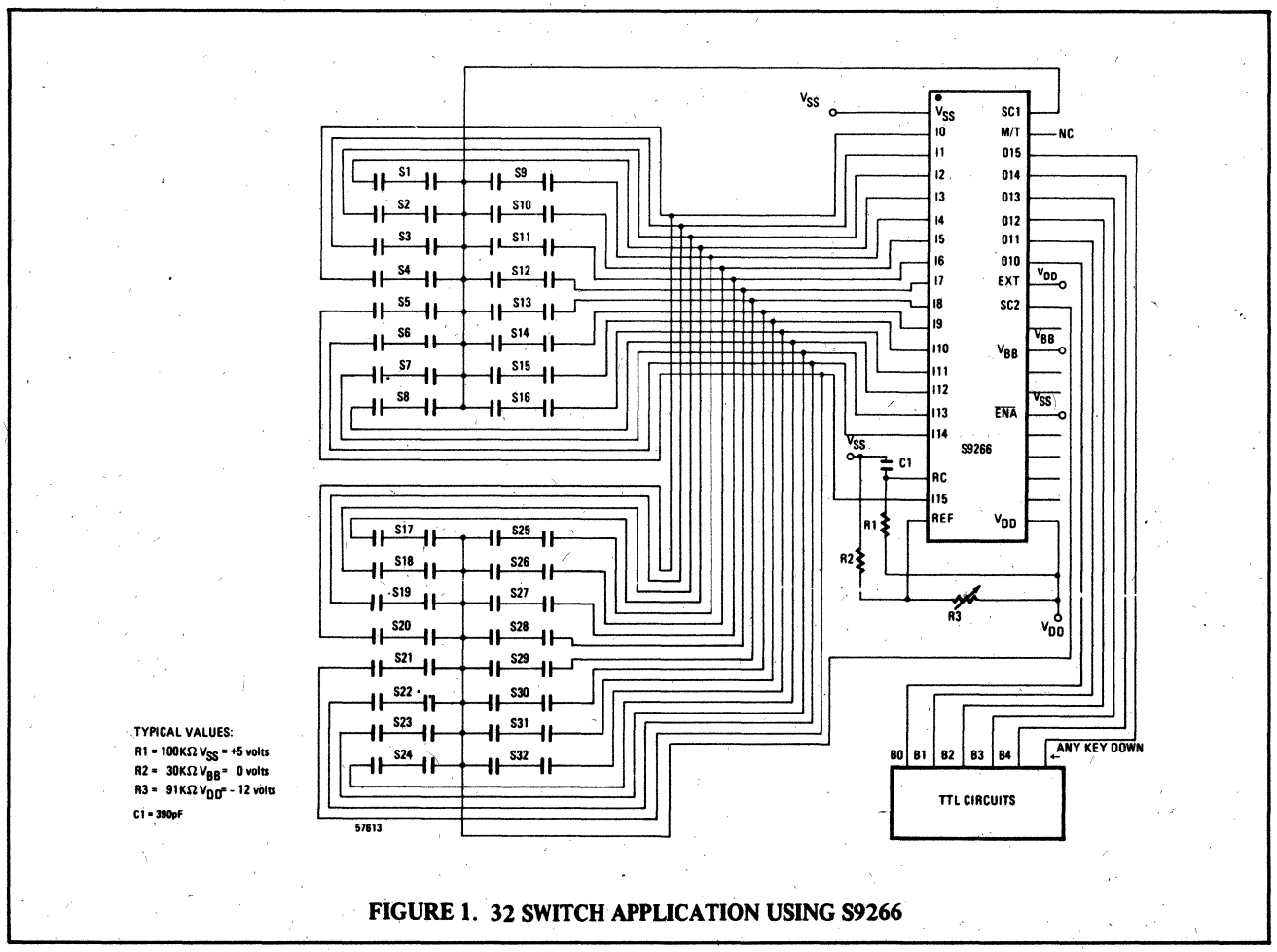

FIGURE 1. 32 SWITCH APPLICATION USING S9266

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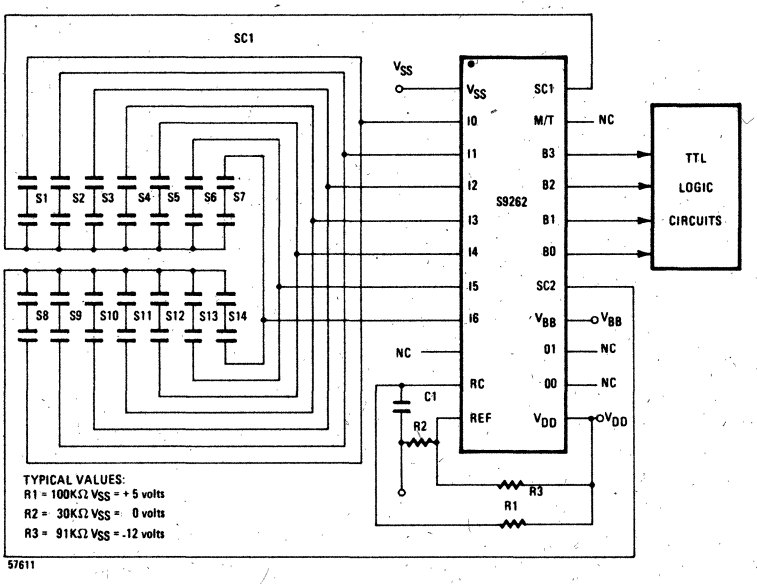

FIGURE 2. 14 SWITCH APPLICATION USING S9262

TABLE 1. OUTPUT ENCODING (V_{BB} = 0 VOLTS)

Input Selection		Corresponding Outputs (Active Output = 0)													
Scan Clock	"1" Inputs	B0	B1	B2	B3	B4	00	01	02	03	04	05	06	AK
SC1	0	1	1	1	1	1	0							0
	1	0	1	1	1	1	1	0						0
	2	1	0	1	1	1		1	0					
	3	0	0	1	1	1			1	0				
	4	1	1	0	1	1				1	0			
	5	0	1	0	1	1					1	0		
	6	1	0	0	1	1						1	0	
	7	0	0	0	1	1							1	
	8	1	1	1	0	1								
	9	0	1	1	0	1								
	10	1	0	1	0	1								
	11	0	0	1	0	1								
	12	1	1	0	0	1								
	13	0	1	0	0	1								
	14	1	0	0	0	1								
SC1	15	0	0	0	0	1								
SC2	0	1	1	1	1	0								
	1	0	1	1	1	0								
	2	1	0	1	1	0								
	3	0	0	1	1	0								
	4	1	1	0	1	0								
	5	0	1	0	1	0								
	6	1	0	0	1	0								
	7	0	0	0	1	0								
	8	1	1	1	0	0								
	9	0	1	1	0	0								
	10	1	0	1	0	0								
	11	0	0	1	0	0								
	12	1	1	0	0	0								
	13	0	1	0	0	0								
	14	1	0	0	0	0								
SC2	15	0	0	0	0	0	1	1	1	1	1	1	1	0
–	No Key Touched	1	1	1	1	1	1	1	1	1	1	1	1	1

ENA INPUT

Available on the S9266, the $\overline{ENA}$ input allows the outputs to be bussed and may be gated off by application of a logic 1 level. V_{SS} applied to the input enables all five outputs and AK.

EXT

The EXT pin is available on the S9266 and is used to supply a higher clock voltage to the TouchControl panel whenever that may be necessitated by smaller touch switch size. When the higher clock voltage level for SC1 and SC2 is not required, this pin should be connected to V_{DD}.

TOUCHCONTROL APPLICATION NOTES

PANEL CONSTRUCTION

A TouchControl switch panel consists of a single sheet of a rigid material with conductive surfaces applied on both sides as shown in Figure 3.

A number of materials may be used for touch panels, the selection of the material most suited for a particular application being dependent on such things as durability, appearance, ease of assembly, cost, and dielectric constant of the material.

Regardless of the selected panel material, a touch switch is formed by applying a single conductive surface to its front surface with two other conductive surfaces applied directly in line on the reverse side of the panel. Figure 3 shows three views of a typical touch panel containing two TouchControl switches. On switch one, conductive surface A is applied to the front of the panel and is the surface to be touched to effect a switch closure. Surfaces B and C are applied directly in line with A on the opposite side of the panel. A should cover completely and may overlap surfaces B and C.

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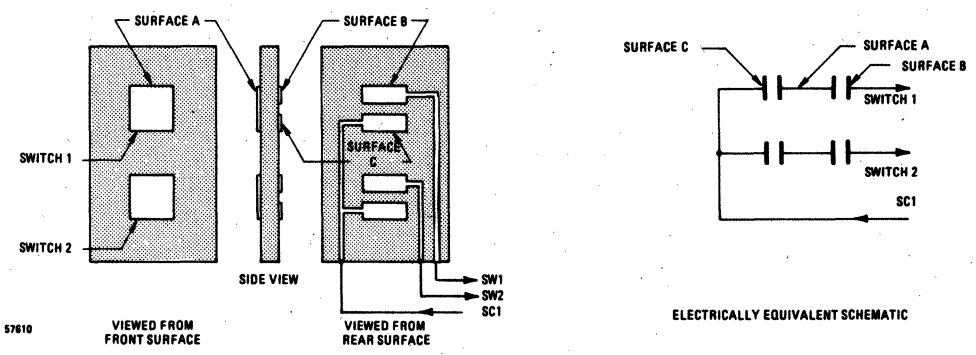

FIGURE 3. CONSTRUCTION OF A TWO SWITCH TOUCHCONTROL PANEL WITH EQUIVALENT ELECTRICAL CIRCUIT.

The application of the conductive surfaces depends on selection of the panel materials. If glass is used, for example, it is common to apply a coating of tin oxide, which is then fired on for durability; rear surface conductors may be screened on with a conductive ink. Touch panels may be made more simply from double-sided printed circuit boards in which the conductive TouchControl surfaces are created by standard etching. For breadboarding purposes, a number of conductive tapes and paints are available and may be applied to a variety of touch panel materials.

ELECTRICAL OPERATION

The three conductive surfaces in a TouchControl switch combine to form two capacitors connected in series, as shown in the schematic diagram of Figure 3. An AC signal generated in the MOS circuit is applied to the rear conductive surface labeled C. This signal is coupled through to surface A by the capacitor formed by C and A. The signal is then coupled to surface B by the capacitor formed by A and B and applied to one of the inputs of the MOS circuit, which detects the signal's presence. When surface A is touched, the amplitude of the signal is significantly decreased because of body capacitance. This is sensed by the MOS circuit, and the appropriate switching function is performed.

TOUCH SWITCH LAYOUT GUIDELINES

AMI TouchControl circuits have been designed to interface with a variety of touch switch configurations. However, there are several guidelines that must be observed to insure a satisfactory TouchControl system.

The size of a TouchControl switch is dependent on the amount of capacitance needed to couple the clock signal to the "I" inputs of the MOS circuits. Because the input capacitance associated with the circuit input is typically five picofarads, it is advisable that each of the two series capacitors formed by the three conductive TouchControl panel surfaces be no less than seven picofarads. Since the capacitance in picofarads can be calculated by $C = 0.22 \in A \div d$, where $\in$ is the dielectric constant, A is area, and d is the material's thickness, it is apparent that minimum switch size is dependent on the thickness and dielectric constant of the panel material. If, for example, the panel is made from 1/8" thick glass with a dielectric constant of 8, then the minimum area of each of the two rear surface conductors is 0.5 sq. inches. Since the touch surface must cover the entire area of the two rear conductors, it must, then, be at least 1.0 sq. inch. It is desirable to separate the two rear-surface conductors by at least 0.125 inches, so the touch surface would be somewhat larger than 1.0 sq. inch. Higher capacitance, and thus smaller touch switches, can be obtained by using epoxy printed circuit material; though the dielectric constant is lower (around 5.0) the thickness can be decreased substantially.

CIRCUIT TO PANEL CONNECTIONS

There are a number of ways to make the necessary connections between TouchControl circuits and panels. A simple approach is to use a printed circuit board for the touch panel. In this case, the connections to the circuit are made by the etched copper pattern. In laying out a printed circuit, it is important to keep the copper traces running to the individual touch pads separated from each other as much as possible. In most instances a minimum spacing of 0.125" between traces is acceptable, though wider spacing might be necessary in cases where traces will run parallel to each other for distances of over six inches. It is also important to keep the clock output (SC1) at least 0.75 inches away from any input trace. These spacing requirements are guidelines to be followed regardless of the touch panel material.

With glass touch panels, a simple method for breadboarding systems is to fasten individual wires onto the conductive surfaces with a conductive epoxy. For production situations, it is possible to locate the electronic circuitry on a separate printed circuit board. Contact to the glass touch panel can be made through spring contacts mounted in the appropriate locations on the circuit board. An alternate approach is to route the traces on the glass to an edge of the glass, making connection through an edge connector, keeping in mind the spacing requirements between traces.

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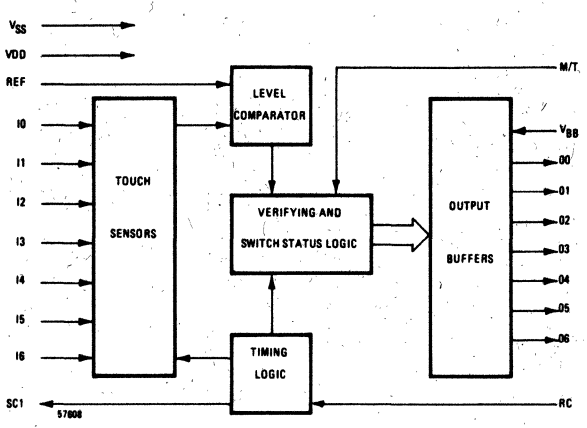
AMERICAN MICROSYSTEMS, INC.

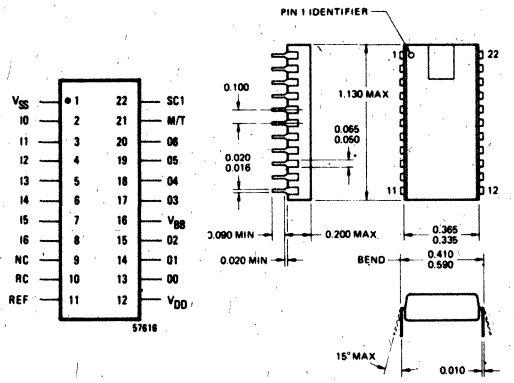
S9260/S9261
S9263/S9264/S9265

TOUCHCONTROL INTERFACE

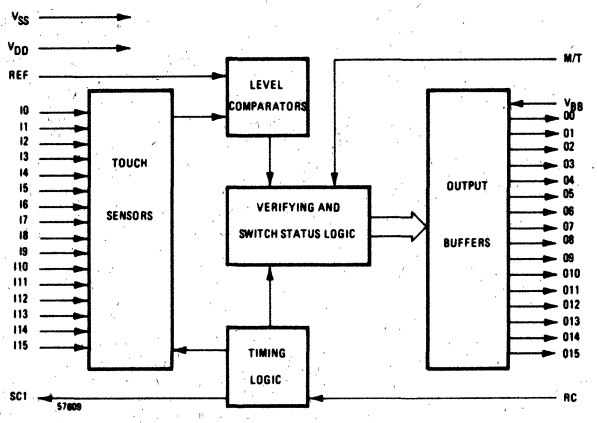
ADVANCED PRODUCT DESCRIPTION



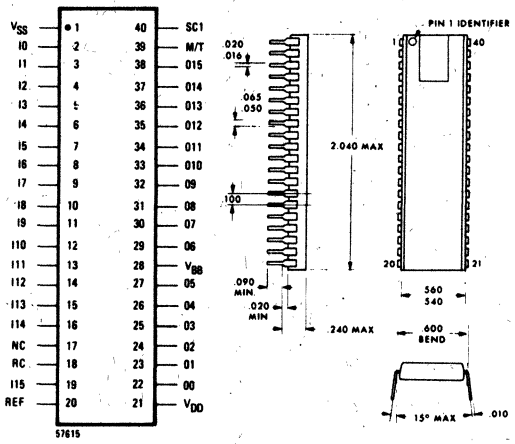
BLOCK DIAGRAM – S9260/S9261 (7 SWITCHES)



PIN/PACKAGE CONFIGURATION
S9260/S9261



BLOCK DIAGRAM – S9263/S9264/S9265 (16 SWITCHES)



PIN/PACKAGE CONFIGURATION
S9263/S9264/S9265

FEATURES

- Interfaces with up to 16 touch switches
- Eliminates contact noise
- Comparator sensing permits use with wide variety of touch switch configurations
- Momentary or toggle operation electrically selectable
- Outputs are TTL/CMOS/MOS compatible
- Simplifies design of touch-sensitive switches

FUNCTIONAL DESCRIPTION

Fabricated with P-channel ion implanted MOS/LSI technology, the S9260 family* of TouchControl integrated circuits has been designed to interface with a variety of touch panel switches and provide a high degree of flexibility in the selection of touch panel materials, layout of touch pad configurations, and design of switching functions. These circuits can interface directly with either seven TouchControl switches (22 lead versions) or sixteen TouchControl switches (40 lead versions). For each TouchControl switch input there is a corresponding output that may be used to interface with various logic families such as CMOS or TTL.

Both momentary and "push on – push off" (toggle) switching operations are available on all AMI TouchControl circuits and are electrically selected by the logic levels of one input pin. To ensure reliable switch action, a built-in delay is incorporated in all circuits requiring a minimum touch time for switch response.

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ABSOLUTE MAXIMUM RATINGS

Voltage on any pin relative to V_{SS}:	+ 0.3V to - 20V	Storage temperature (Ambient)	- 65°C to + 150°C
Operating temperature range:	0°C to + 50°C		

**FOR MULTIPLEXED TOUCHCONTROL CIRCUITS SEE AMI S9262 and S9266.*

ELECTRICAL CHARACTERISTICS

($0°C < T_A < 50°C$; $V_{SS} = 0V$; V_{DD} = - 13.5V to - 18.0V unless otherwise specified.)

SYMBOL	PARAMETER	MIN	TYP	MAX	UNITS	CONDITIONS
V_{IL}	Input logic 0 level – all except "I" inputs.	+ 0.3	0	- 1.5	Volts	Note: M/T input is internally pulled up to V_{SS}
V_{IH}	Input logic 1 level – all except "I" inputs	- 10.0	- 12.0	- 18.0	Volts	
f_{RC}	Internal oscillator frequency measured at RC input.	50		100	kHz	
T_S T_{RST}	Switch delay time Time to reset all latches using M/T input.	50	 100	200	msec msec	Frequency measured at RC Input = 50 kHz
V_{OL} V_{OH}	Output low voltage Output high voltage	V_{SS}		- 1.0 V_{DD}	Volts	$V_{BB} = V_{SS}$; 10K resistive load to V_{DD}
V_{OL} V_{OH}	Output low voltage Output high voltage	V_{SS} V_{BB} + 0.4		V_{SS} - 0.5 V_{BB}	Volts	V_{SS} = +5V; V_{BB} = 0V V_{DD} = 12V; 2800Ω resistive load to V_{SS}
SC1	Scan clock output: Output low voltage Output high voltage	 V_{SS}		 - 1.5 V_{DD}		Max. capacitive loading < 150 pF

OPERATION

Device operation can be understood by referring to Figure 1, depicting a typical application of the S9263. Each of the sixteen pairs of series capacitors labeled S1 – S16 is one touch switch located on a TouchControl panel. (For details on touch panel configuration and operation, see the TouchControl application note included in this APD.) In each capacitor pair, the two common plates represent the conductive area on the control panel surface that is to be touched. The other two plates are formed by two conductive surfaces parallel to the touched surface and located directly under it on the reverse side of the panel. Referring again to Figure 1, the S9263 generates a clock signal on output SC1 that is applied to one plate of each capacitor pair; this signal passes through the two series capacitors and is detected in the MOS circuit. When a panel switch surface is touched, the signal level into the chip dimishes, and the on-chip differential amplifier senses the change and performs the appropriate switching function. For example, if surface S1 is touched, the signal at input 13 decreases, and output 03, normally open, now becomes active and drives the S1 input to the TTL circuitry toward voltage level V_{BB}.

I INPUTS

Inputs from the touch switch pads to the TouchControl circuit are labeled I0 through I15 (S9263, S9264, and S9265) or I0 through I6 (S9260 and S9261). Each I input relates directly to an O output of identical numeral.

RC INPUT

A resistor connected to V_{DD} and a capacitor connected to V_{SS} are connected to the RC input pin to establish the on-chip clock frequency that controls the touch switch delay time. Nominal values for these components are suggested in Figure 1, but they may be varied to change clock frequency over a range of 50 kHz to 100 kHz.

REF INPUT

In order to allow flexibility in the choice of TouchControl panel materials, switch layout, and switch size, AMI Touch Control inputs have been designed to detect a differential change rather than an absolute change in level. To obtain a reference level, two resistors are connected to input REF, one to V_{SS} and the other to V_{DD}.

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O OUTPUTS

Each output pin labeled "O" corresponds to an input pin labeled "1." Whenever an input is selected, the output becomes active and will drive an external load toward supply voltage V_{BB}. When outputs are not active, they are high impedance open drain.

V_{BB} SUPPLY

The sources of all output devices are common and connected to pin V_{BB}. This allows TTL compatibility as shown in Figure 1, as well as the ability to drive higher level signals. For instance, if V_{SS} = 0 volts, V_{DD} = - 16 volts, and V_{BB} = V_{SS}, then active outputs would drive a load connected to V_{DD} towards V_{SS}. The V_{BB} pin can be used also to switch analog signals; in this configuration the analog signals are applied to the "O" pins and V_{BB} is the output pin.

M/T INPUT

The M/T input pin selects the mode of switch operation, either momentary or toggle. With no connection to the M/T pin momentary operation is selected, and appropriate outputs are active only for the duration of touching a switch. In this mode, no output is active when no switch is touched. A V_{DD} level applied to M/T causes the circuit to operate in the toggle mode. In this condition, the brief touch of any switch will turn on the appropriate output, which will remain latched on until the switch is touched again. Subsequent activations of the switch will toggle the corresponding output on and off alternately. To reset all outputs when the toggle mode is selected, a pulse of V_{SS} level may be applied to the M/T input.

SCI OUTPUT

The SC1 output provides the clock signal for the Touch-Control panel. Its frequency is determined by the RC time constant, and it is connected in common with one of each of the two common conductive surfaces on the reverse side of the touch panel.

MOMENTARY AND TOGGLE COMBINATION

The S9261, S9264, and S9265 contain several outputs that are permanently in the momentary mode of operation. With the M/T input at V_{SS} these parts function identically to the S9260 and S9263. With M/T at a logic 1 level, however, the S9261 has four momentary and three toggle inputs. Table 1 shows the combinations available on all three parts.

TABLE 1. COMPARISON OF FEATURES

Part Number	Pin Count	Touch Switch Capacity			Number of Outputs
		Total Touch Switch Interface Capability	Touch Inputs Selectable For Either Momentary Or Toggle Operation Through Use of M/T Input	Touch Switch Inputs Fixed In Momentary Operation (Not affected by state of M/T input)	
S9260	22	7	7	0	7
S9261	22	7	3 (I4 thru I6)	4 (I0 thru I3)	7
S9263	40	16	16	0	16
S9264	40	16	8 (I8 thru I15)	8 (I0 thru I7)	16
S9265	40	16	12 (I4 thru I15)	4 (I0 thru I3)	16

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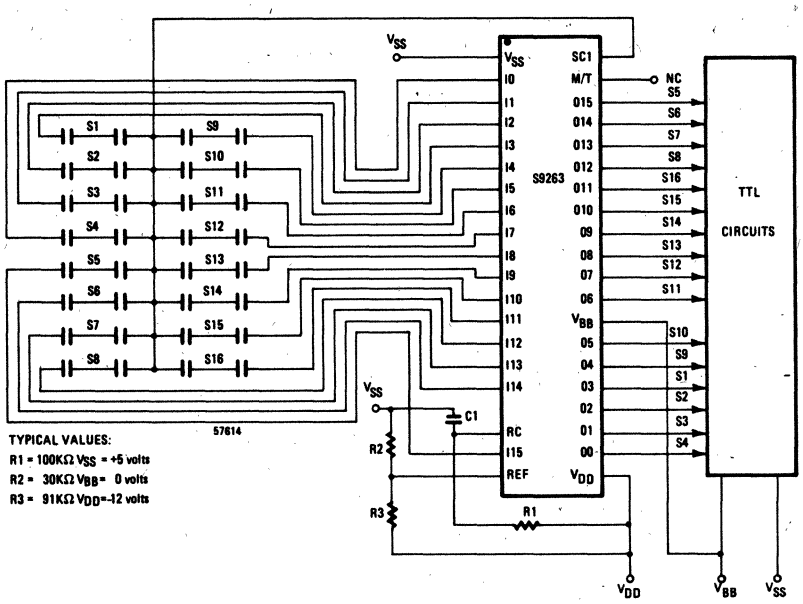

FIGURE 1. 16 SWITCH APPLICATION USING S9263

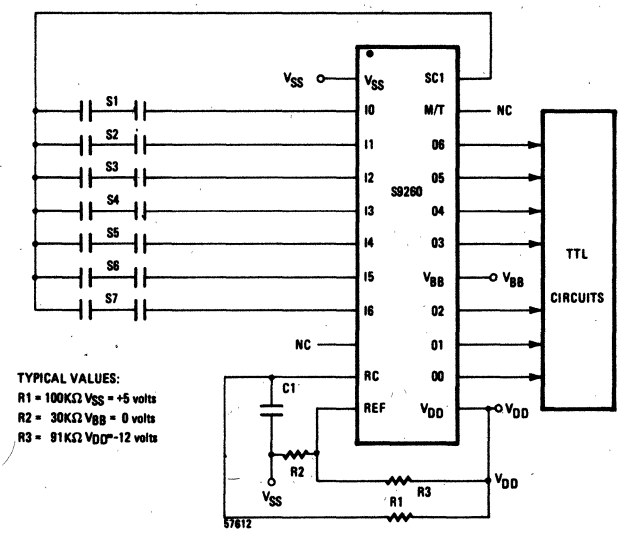

FIGURE 2. 7 SWITCH APPLICATION USING S9260

TOUCHCONTROL APPLICATION NOTES

See Application Notes at the end of S9262/S9266 data sheet pages in this Section.

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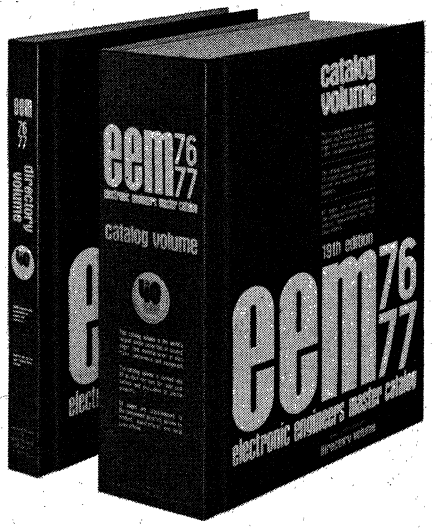

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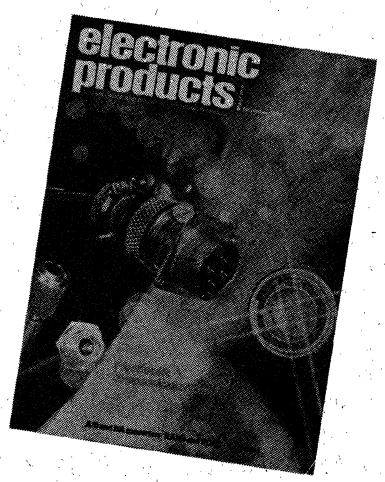

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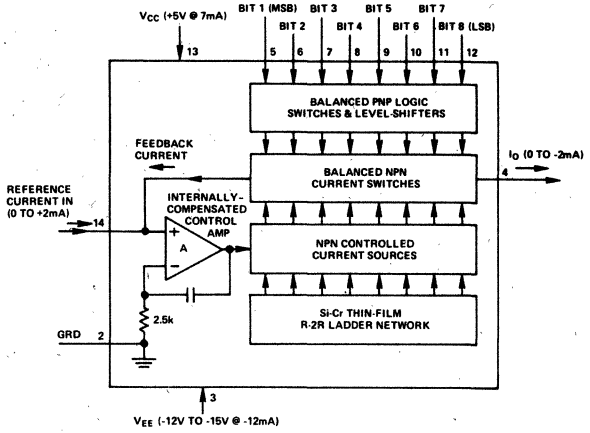
ANALOG DEVICES

8 Bit Monolithic D/A Converter

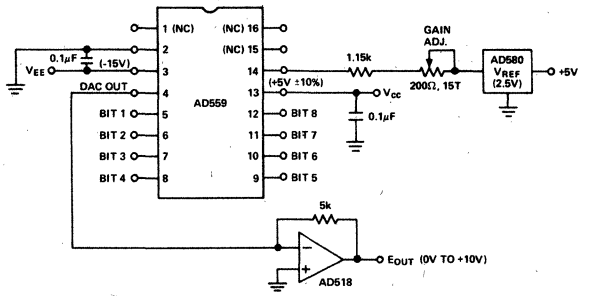
AD559

FEATURES

- Replaces the Motorola 1408/1508 8-Bit DAC
- Guaranteed Monotonicity and Relative Accuracy Over Full Temperature Range
- Single Chip Monolithic Construction
- Hermetic 16 Pin Ceramic DIP
- High Stability SiCr Thin Film Resistors
- Low Cost



AD559 Block Diagram



Unipolar Output

PRODUCT DESCRIPTION

The AD559 is a low cost integrated circuit 8-bit digital-to-analog converter consisting of specially designed, precision bipolar switches, a control amplifier, and high stability silicon chromium thin-film resistors, all on a single monolithic chip. The single chip is mounted in a hermetically-sealed ceramic 16 lead dual in-line package.

A unique combination of advanced circuit design, and high stability SiCr thin film resistor processing provides the AD559 with true 8-bit accuracy at low I.C. costs. The maximum error over the full operating temperature range is limited to ½LSB and the gain temperature coefficient is limited to 20ppm/°C typical. Monotonicity is guaranteed over the full operating temperature range of the devices.

The AD559 is recommended for all low cost, 8-bit DAC requirements and as a replacement for the Motorola 1408/1508 8-bit DAC, in most applications. The AD559K is specified for operation over the 0 to +75°C temperature range and the AD559S for operation over the full extended temperature range, -55°C to +125°C.

ORDERING INFORMATION

MODEL	TEMP. RANGE (°C)	ACCURACY (LSB MAX)	PRICE (100's) ($)
AD559K/BIN	0 to +75	±½	$5.95
AD559S/BIN	-55 to +125	±½	$8.55

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ANALOG DEVICES

Low Cost 10-Bit Monolithic D/A Converter

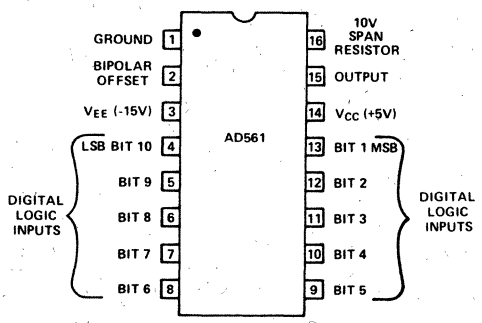
AD561

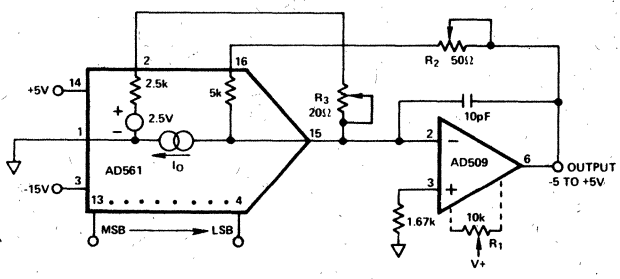
PRELIMINARY TECHNICAL DATA

FEATURES

- Low Cost ($9.95 in 100's, AD561J)
- Complete Current Output Converter
- High Stability Buried Zener Reference
- Laser Trimmed to High Accuracy (1/4LSB Max Error, AD561K, T)
- Trimmed Output Application Resistors for 0 to +10, ±5 Volt Ranges
- Fast Settling – 250ns to 1/2LSB
- Guaranteed Monotonicity Over Full Operating Temperature Range
- TTL/DTL and CMOS Compatible (Positive True Logic)
- Single Chip Monolithic Construction
- Hermetically-Sealed Ceramic DIP (All Grades)

PIN CONFIGURATION
TOP VIEW





±5V Buffered Bipolar Voltage Output

PRODUCT DESCRIPTION

The AD561 is an integrated circuit 10-bit digital-to-analog converter combined with a high stability voltage reference fabricated on a single monolithic chip. Using 10 precision high-speed current-steering switches, a control amplifier, voltage reference, and laser-trimmed thin-film SiCr resistor network, the device produces a fast, accurate analog output current. Laser trimmed output application resistors are also included to facilitate accurate, stable current-to-voltage conversion; they are trimmed to 0.1% accuracy, thus eliminating external trimmers in many situations.

Several important technologies combine to make the AD561 the most accurate and most stable 10-bit DAC available. The low temperature coefficient, high stability thin-film network is trimmed at the wafer level by a fine resolution laser system to 0.01% typical linearity.

The AD561 also incorporates a low noise, high stability subsurface zener diode to produce a reference voltage with excellent long term stability and temperature cycle characteristics which challenge the best discrete zener references. A temperature compensation circuit is laser-trimmed to allow custom correction of the temperature coefficient of each device. This results in a typical full-scale temperature coefficient of 15ppm/°C.

All grades are packaged in a 16-pin hermetically-sealed ceramic dual-in-line package. The AD561J and K versions are specified for operation over the 0 to +70°C temperature range, the AD561S and T for operation over the full military temperature range from -55°C to +125°C.

ORDERING GUIDE

MODEL	TEMP. RANGE (°C)	ACCURACY @ +25°C (LSB MAX)	GAIN T.C. (of F.S./°C) ppm MAX	PRICE (100's) ($)
AD561J	0 to +70	±½	80	$ 9.95
AD561K	0 to +70	±¼	30	$15.00
AD561S	-55 to +125	±½	60	$18.00
AD561S/883B*	-55 to +125	±½	60	$24.00
AD561T	-55 to +125	±¼	30	$32.00
AD561T/883B*	-55 to +125	±¼	30	$40.00

*The AD561S/883B and AD561T/883B are fully processed to MIL-STD-883A, Method 5004, Class B. The complete procedure list is available on request.

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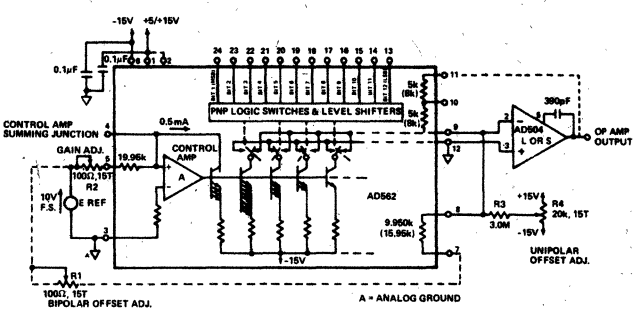
ANALOG DEVICES

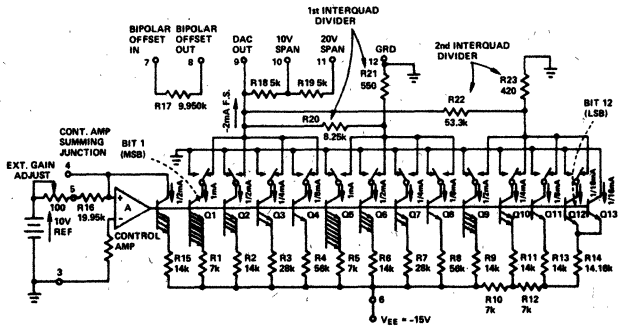
Integrated Circuit 12-Bit D/A Converter

AD562

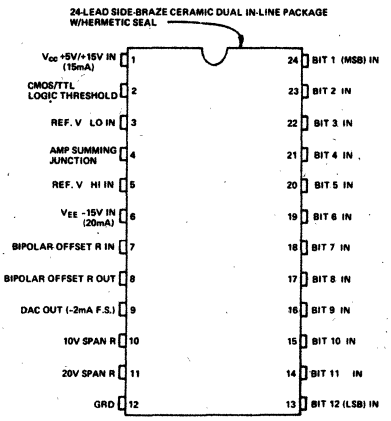
FEATURES
- Low Cost: $39 (100's, AD562K)
- True 12-Bit Accuracy (±¼ LSB)
- All Active Elements On Single LSI Linear Chip
- Guaranteed Monotonicity Over Full Temperature Range
- Hermetic 24-Pin DIP
- TTL/DTL and CMOS Compatibility



AD562 Functional Schematic



Ladder Network and Inter-Quad Divider Current Scaling



PIN CONFIGURATION
TOP VIEW

PRODUCT DESCRIPTION

The AD562 is an integrated circuit 12-bit digital-to-analog converter consisting of a specially designed precision bipolar switch and control amplifier chip and a compatible high stability silicon chromium thin film resistor chip. The two IC chips are internally connected and mounted in a hermetically-sealed ceramic 24-lead dual-in-line package.

A unique combination of advanced circuit design, high stability SiCr thin film resistor processing, and laser trimming technology provides the AD562 with true 12-bit accuracy. The maximum error at +25°C is limited to ¼ LSB (S version) and the gain temperature coefficient is limited to 3ppm/°C max. Monotonicity is guaranteed over the full operating temperature range of the devices.

The AD562 is recommended for all high accuracy 12-bit D/A converter applications where true 12-bit performance is required and small size and low cost are primary considerations. The AD562 is also ideal for use in constructing A/D conversion systems and as a building block for higher resolution D/A systems. The AD562K is specified for operation over the 0 to +70°C temperature range, the AD562A for operation over the −25 to +85°C temperature range, and the AD562S for operation over the full extended temperature range of −55 to +125°C.

ORDERING INFORMATION

MODEL	TEMP. RANGE (°C)	ACCURACY (LSB MAX)	PRICE (100's) ($)
AD562K/BIN	0 to +70	±¼	$ 39.00
AD562K/BCD	0 to +70	±¼	$ 39.00
AD562A/BIN	-25 to +85	±¼	$ 49.00
AD562A/BCD	-25 to +85	±¼	$ 49.00
AD562S/BIN	-55 to +125	±¼	$100.00
AD562S/BCD	-55 to +125	±¼	$100.00

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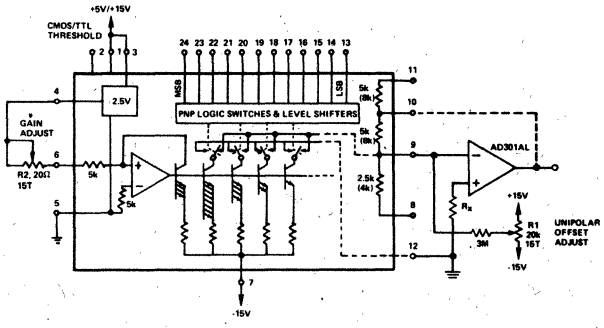
ANALOG DEVICES

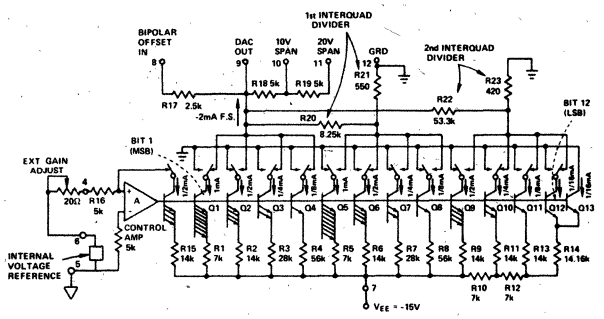
Low Cost IC 12-Bit D/A Converter

AD563

FEATURES
- Extremely Low Cost: $27 (100's, AD563J)
- True 12-Bit Accuracy: ±¼LSB max (AD563K, S, T)
- Guaranteed Differential Nonlinearity: ±½LSB max
- Positive True Logic
- Includes Internal Reference
- Guaranteed Monotonicity Over Full Temperature Range
- Low Overall Gain T.C.: 10ppm/°C max (AD563T)
  30ppm/°C max (AD563J)
- Hermetic 24 pin DIP
- TTL/DTL and CMOS Compatibility



AD563 in Typical Unipolar Connection Scheme



Ladder Network and Inter-Quad Divider Current Scaling

PRODUCT DESCRIPTION

The AD563 is an integrated circuit 12-bit digital-to-analog converter consisting of a specially designed precision bipolar switch and control amplifier chip, a compatible high stability silicon chromium thin film resistor chip, and a low drift, voltage reference chip. The three I.C. chips are internally connected and mounted in a hermetically-sealed, ceramic 24 lead dual-in-line package to produce a self contained current output DAC.

A unique combination of advanced circuit design, high stability SiCr thin film resistor processing and laser trimming technology, provides the AD563 with true 12-bit accuracy. The maximum error at +25°C is limited to ¼LSB (K, S and T versions) with the gain temperature coefficient limited to 10ppm/°C max, including the effects of the internal reference. Monotonicity on all versions is guaranteed over the full operating temperature range.

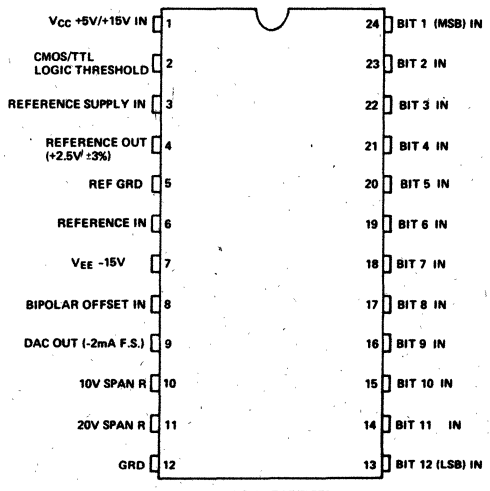
The AD563 is recommended for all high accuracy 12-bit D/A converter applications where true 12-bit performance is required, but low cost and small size are considerations. The AD563 is also ideal for use in constructing A/D conversion systems and as a building block for higher resolution D/A systems. The AD563J and K are specified for operation over the 0 to +70°C temperature range, the AD563S and T for operation over the military temperature range, -55°C to +125°C.

ORDERING INFORMATION

MODEL	TEMP. RANGE (°C)	ACCURACY (LSB MAX)	PRICE (100's) ($)
AD563J/BIN	0 to +70	±½	$ 27.00
AD563J/BCD	0 to +70	±½	$ 27.00
AD563K/BIN	0 to +70	±¼	$ 42.00
AD563K/BCD	0 to +70	±¼	$ 42.00
AD563S/BIN	-55 to +125	±¼	$110.00
AD563S/BCD	-55 to +125	±¼	$110.00
AD563T/BIN	-55 to +125	±¼	$140.00
AD563T/BCD	-55 to +125	±¼	$140.00

PIN CONFIGURATION

24 LEAD DUAL IN-LINE PACKAGE



TOP VIEW

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ANALOG DEVICES

CMOS 10 & 12 Bit Monolithic Multiplying D/A Converters

AD7520, AD7521

FEATURES

AD7520:	**10 Bit Resolution**
AD7521:	**12 Bit Resolution**
Linearity:	**8, 9 and 10 Bit**
Nonlinearity Tempco:	**2 ppM of FSR/°C**
Low Power Dissipation:	**20 mW**
Current Settling Time:	**500 ns**
Feedthrough Error:	**1/2 LSB @ 100 kHz**
TTL/DTL/CMOS Compatible	

GENERAL DESCRIPTION

The AD7520 (AD7521) is a low cost, monolithic 10-bit (12-bit) multiplying digital-to-analog converter packaged in a 16-pin (18-pin) DIP. The devices use advanced CMOS and thin film technologies providing up to 10-bit accuracy with TTL/DTL/CMOS compatibility.

The AD7520 (AD7521) operates from +5V to +15V supply and dissipates only 20 mW, including the ladder network.

Typical AD7520 (AD7521) applications include: digital/analog multiplication, CRT character generation, programmable power supplies, digitally controlled gain circuits, etc.

ORDERING INFORMATION

Nonlinearity	Temperature Range		
	0°C to +70°C	−25°C to +85°C	−55°C to +125°C
0.2% (8-Bit)	AD7520JN AD7521JN	AD7520JD AD7521JD	AD7520SD AD7521SD
0.1% (9-Bit)	AD7520KN AD7521KN	AD7520KD AD7521KD	AD7520TD AD7521TD
0.05% (10-Bit)	AD7520LN AD7521LN	AD7520LD AD7521LD	AD7520UD AD7521UD

PRICE INFORMATION

Model	Price (100 Pcs)	Model	Price (100 Pcs)
AD7520JN	$12.00	AD7521JN	$15.00
AD7520KN	16.25	AD7521KN	19.25
AD7520LN	22.00	AD7521LN	25.00
AD7520JD	17.00	AD7521JD	20.00
AD7520KD	25.00	AD7521KD	28.00
AD7520LD	33.00	AD7521LD	36.00
AD7520SD	33.00	AD7521SD	37.00
AD7520TD	49.00	AD7521TD	53.00
AD7520UD	69.00	AD7521UD	73.00

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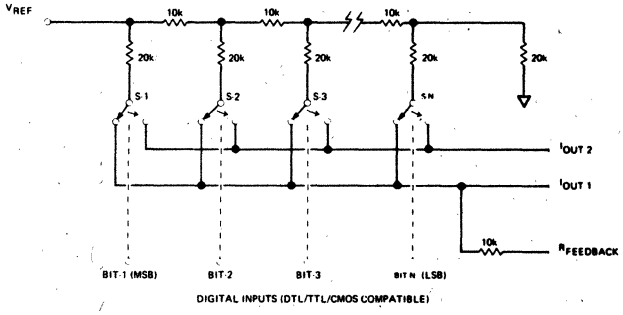
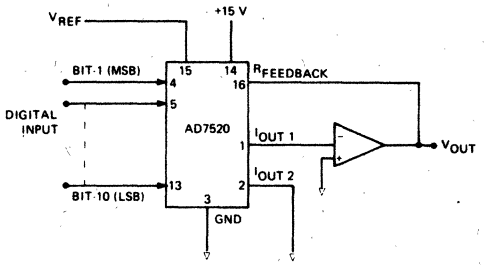
FUNCTIONAL DIAGRAM



AD7520: N=10
AD7521: N=12
Logic: A switch is closed to $I_{OUT\ 1}$ for its digital input in a "HIGH" state.

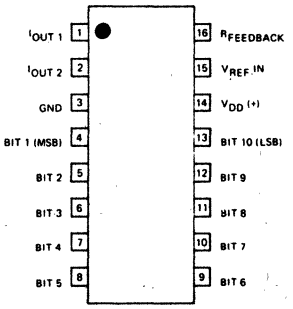
TYPICAL APPLICATION



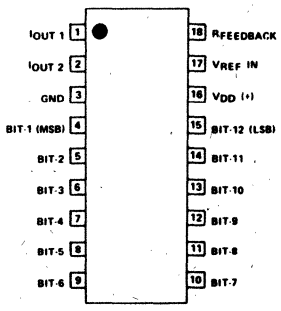
PIN CONFIGURATION

TOP VIEW

AD7520



AD7521



PACKAGE IDENTIFICATION

Suffix D: Ceramic DIP package
Suffix N: Plastic DIP package

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CMOS 10 & 12 Bit Monolithic Multiplying D/A Converters

AD7530, AD7531

FEATURES

AD7530: 10-Bit Resolution
AD7531: 12-Bit Resolution
8, 9 & 10 Bit Linearity
DTL/TTL/CMOS Compatible
Nonlinearity Tempco: 2 ppM of FSR/°C
Low Power Dissipation: 20 mW
Current Settling Time: 500 ns
Feedthrough Error: 10 mVp-p @ 50 kHz
Low Cost

GENERAL DESCRIPTION

The AD7530 (AD7531) is a low cost, monolithic 10-bit (12-bit) multiplying digital-to-analog converter packaged in a 16-pin (18-pin) DIP. The device uses advanced CMOS and thin film technologies providing up to 10-bit accuracy with DTL/TTL/CMOS compatibility.

The AD7530 (AD7531) operates from a +5 V to +15 V supply and dissipates only 20 mW, including the ladder network.

Typical applications include: digital/analog multiplication, CRT character generation, programmable power supplies, digitally controlled gain circuits, etc.

ORDERING INFORMATION

Nonlinearity	Temperature Range	
	0°C to +70°C	−25°C to +85°C
0.2% (8-Bit)	AD7530JN AD7531JN	AD7530JD AD7531JD
0.1% (9-Bit)	AD7530KN AD7531KN	AD7530KD AD7531KD
0.05% (10-Bit)	AD7530LN AD7531LN	AD7530LD AD7531LD

PRICE INFORMATION

Model	Price (100 Pcs)	Model	Price (100 Pcs)
AD7530JN	$ 8.00	AD7531JN	$ 8.00
AD7530KN	10.50	AD7531KN	10.50
AD7530LN	15.00	AD7531LN	23.50
AD7530JD	12.00	AD7531JD	12.00
AD7530KD	15.00	AD7531KD	15.00
AD7530LD	23.00	AD7531LD	33.00

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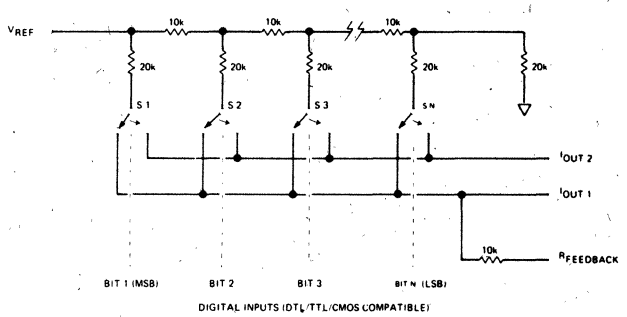
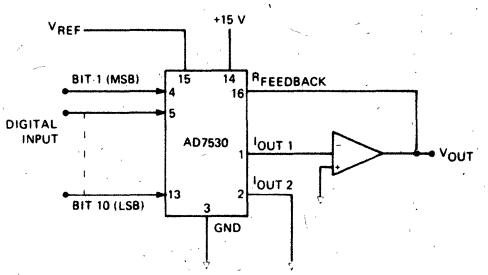
FUNCTIONAL DIAGRAM

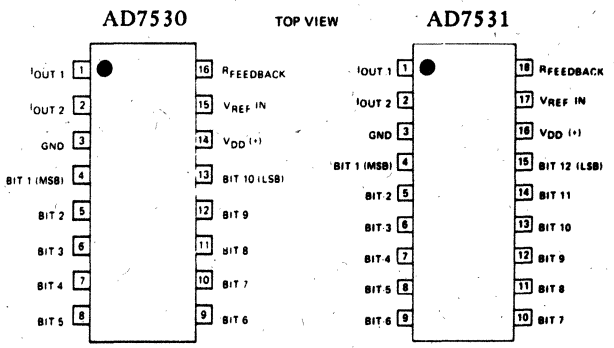


AD7530: N = 10
AD7531: N = 12
(Switches shown in "High" state)

TYPICAL APPLICATION



PIN CONFIGURATION



PACKAGE IDENTIFICATION

Suffix D: Ceramic DIP package
Suffix N: Plastic DIP package

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ANALOG DEVICES

CMOS 10-Bit, Buffered Multiplying D/A Converter

AD7522

FEATURES

- 10-Bit Resolution
- 8, 9, & 10-Bit Linearity
- Microprocessor Compatible
- Double Buffered Inputs
- Serial or Parallel Loading
- DTL/TTL/CMOS Direct Interface
- Nonlinearity Tempco: 2ppM of FSR/°C
- Gain Tempco: 10ppM of FSR/°C
- Very Low Power Dissipation
- Very Low Feedthrough

GENERAL DESCRIPTION

The AD7522 is a monolithic CMOS 10-bit multiplying D/A converter, with an input buffer and a holding register, allowing direct interface with microprocessors. Most applications require the addition of only an operational amplifier and a reference voltage.

The key to easy interface to a data bus is the AD7522's ability to load the input buffer in two bytes (an 8-bit and a 2-bit byte), and subsequently move this data to a holding register, where the digital word is converted into an analog current or voltage (with external operational amplifier). The input loading of either 8 or 10 bits can be done in a parallel or serial mode.

The AD7522 is packaged in a 28-pin DIP, and operates with a +15V main supply at 2mA max, and a logic supply of +5V for TTL interface, or +10 to +15V for CMOS interface.

A thin film on high density CMOS process, using silicon nitride passivation, ensures high reliability and excellent stability.

ORDERING INFORMATION

Nonlinearity	Temperature Range		
	0°C to +70°C	−25°C to +85°C	−55°C to +125°C
0.2% FSR (8-Bit)	AD7522JN	AD7522JD	AD7522SD
0.1% FSR (9-Bit)	AD7522KN	AD7522KD	AD7522TD
0.05% FSR (10-Bit)	AD7522LN	AD7522LD	AD7522UD

PACKAGE IDENTIFICATION

Suffix "D": Ceramic DIP Package
Suffix "N": Plastic DIP Package

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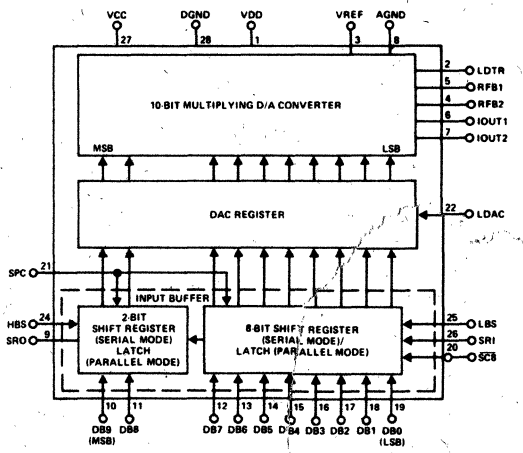
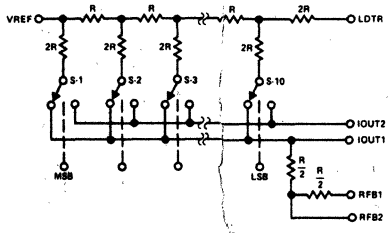
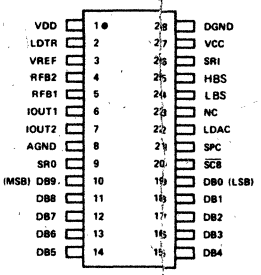
FUNCTIONAL DIAGRAM



D/A CONVERTER DIAGRAM



PIN CONFIGURATION



PRICE INFORMATION

Model	Price (100 Pcs)	Model	Price (100 Pcs)
AD7522JN	$15.00		
AD7522KN	17.00		
AD7522LN	25.00		
AD7522JD	21.00	AD7522SD	$41.00
AD7522KD	25.00	AD7522TD	51.00
AD7522LD	37.00	AD7522UD	99.00

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Pin Function Description

PIN	MNEMONIC	DESCRIPTION
1	VDD	+15V (nominal) Main Supply.
2	LDTR	R-2R Ladder Termination Resistor. Normally grounded for unipolar operation or terminated at IOUT2 for bipolar operation.
3	VREF	Reference Voltage Input. Since the AD7522 is a multiplying DAC, VREF may vary over the range of ±10V.
4	RFB2	Rfeedback ÷ 2; gives full scale equal to VREF/2.
5	RFB1	Rfeedback, used for normal unity gain (at full scale) D/A conversion.
6	IOUT1	DAC Current OUT-1 Bus. Normally terminated at virtual ground of output amplifier.
7	IOUT2	DAC Current OUT-2 Bus, terminated at ground for unipolar operation, or virtual ground of op amp for bipolar operation.
8	AGND	Analog Ground. Back gate of DAC N-channel SPDT current steering switches.
9	SRO	Serial Output. An auxiliary output for recovering data in the input buffer.
10	DB9	Data Bit 9. Most significant parallel data input.
11	DB8	Data Bit 8.
12	DB7	Data Bit 7.
13	DB6	Data Bit 6.
14	DB5	Data Bit 5.
15	DB4	Data Bit 4.
16	DB3	Data Bit 3.
17	DB2	Data Bit 2.
18	DB1	Data Bit 1.
19	DB0	Data Bit 0. Least significant parallel data input.
20	$\overline{SC8}$	8-Bit Short Cycle Control. When in serial mode, if $\overline{SC8}$ is held to logic "0," the two least significant input latches in the input buffer are bypassed to provide proper serial loading of 8-bit serial words. If $\overline{SC8}$ is held to logic "1," the AD7522 will accept a 10-bit serial word. Data bits 0(LSB) and $\overline{DB1}$ are in a parallel load mode when $\overline{SC8}$ = 0, and should be tied to a logic low state to prevent false data from being loaded.

Note 1

PIN	MNEMONIC	DESCRIPTION
21	SPC	Serial/Parallel Control. If SPC is a logic "0," the AD7522 will load parallel data appearing on DB0 through DB9 into the input buffer when the appropriate strobe inputs are exercised (see HBS and LBS). If SPC is a logic "1," the AD7522 will load serial data appearing on Pin 26 into the input buffers. Each serial data bit must be "strobed" into the buffer with the HBS and LBS.
22	LDAC	Load DAC: When LDAC is a logic "0," the AD7522 is in the "hold" mode, and digital activity in the input buffer is locked out. When LDAC is a logic "1," the AD7522 is in the "load" mode, and data in the input buffer loads the DAC register.
23	NC	No Connection.
24	LBS	Low Byte Strobe. When in "parallel load" mode (SPC = 0), parallel data appearing on the DB0 (LSB) through DB7 inputs will be "clocked" into the input buffer on the positive going edge of the LBS. When in "serial load" mode (SPC = 1), serial data bits appearing at the serial input terminal, Pin 26, will be "clocked" into the input buffer on the positive going edge of HBS and LBS. (HBS and LBS must be clocked simultaneously when in "serial load" mode.)
25	HBS	High Byte Strobe. When in "parallel load" mode (SPC = 0), parallel data appearing on the DB9 (MSB) and DB8 data inputs will be "clocked" into the input buffer on the positive going edge of HBS. When in "serial load" mode (SPC = 1), serial data bits appearing at the serial input terminal, Pin 26, will be "clocked" into the input buffer on the positive going edges of HBS and LBS. (HBS and LBS must be clocked simultaneously when in "serial load" mode.)
26	SRI	Serial Input.
27	VCC	Logic Supply. If +5V is applied, all digital inputs/outputs are TTL compatible. If +10V to +15V is applied, digital inputs/outputs are CMOS compatible.
28	DGND	Digital Ground.

Note 1: Logic "1" applied to a data bit steers that bit's current to the IOUT1 terminal.

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ANALOG DEVICES

CMOS 13-Bit Monolithic A/D Converter

AD7550

FEATURES

- Resolution: 13 Bits, 2's Complement
- Relative Accuracy: ±1/2LSB
- "Quad Slope" Precision
  - Gaindrift: 1 ppm/°C
  - Offsetdrift: 1 ppm/°C
- Microprocessor Compatible
- Ratiometric
- Overrange Flag
- Very Low Power Dissipation
- TTL/CMOS Compatible
- CMOS Monolithic Construction

GENERAL DESCRIPTION

The AD7550 is a 13-bit (2's complement) monolithic CMOS analog-to-digital converter on a 118 x 125 mil die packaged in a 40-pin ceramic DIP. Outstanding accuracy and stability (1 ppm/°C) is obtained due to its revolutionary integrating technique, called "Quad Slope" (Analog Devices patent No. 3872466). This conversion consists of four slopes of integration as opposed to the traditional dual slope and provides much higher precision.

The AD7550 parallel output data lines have three-state logic and are microprocessor compatible through the use of two enable lines which control the lower eight LSB's (low byte enable) and the five MBS's (high byte enable). An overrange flag is also available which together with the BUSY and BUSY flags can be interrogated through the STATUS ENABLE providing easy microprocessor interface.

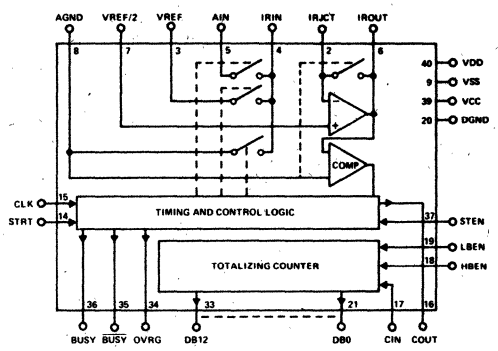
The AD7550 conversion time is about 40 ms with a 1 MHz clock which can be externally controlled or internally generated by simply connecting a capacitor to the clock pin. A positive start pulse can be self-generated by having a capacitor on the start pin or can be externally applied.

For most applications, the AD7550 needs only three resistors, one capacitor, and a reference voltage since the integrating amplifier, comparator, switches and digital logic are all on the CMOS chip!

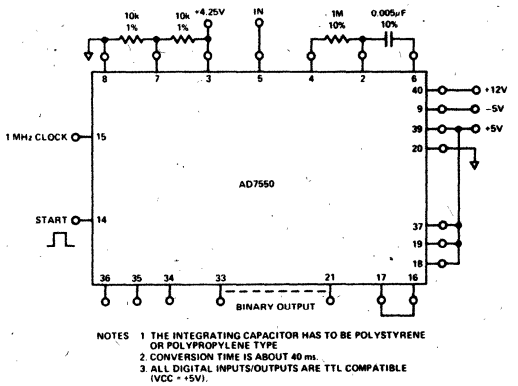
A wide range of power supply voltages (±5V to ±12V) with minuscule current requirements make the AD7550 ideal for low power and/or battery operated applications. Selection of the logic (VCC) supply voltage (+5V to +12V) provides direct TTL or CMOS interface on the digital input/output lines.

The AD7550 uses a high density CMOS process featuring double layer metal and silicon nitride passivation to ensure high reliability and long-term stability.

FUNCTIONAL DIAGRAM

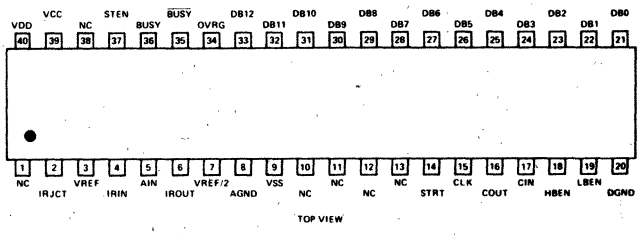


BASIC OPERATION



NOTES
1. THE INTEGRATING CAPACITOR HAS TO BE POLYSTYRENE OR POLYPROPYLENE TYPE
2. CONVERSION TIME IS ABOUT 40 ms.
3. ALL DIGITAL INPUTS/OUTPUTS ARE TTL COMPATIBLE (VCC = +5V).

PIN CONFIGURATION



TOP VIEW

ORDERING INFORMATION

Model	Temperature Range	Price (100 Pcs)
AD7550BD	−25°C to +85°C	$25.00

Suffix D: Ceramic Package

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Pin Function Description

PIN	MNEMONIC	DESCRIPTION
1	NC	No Connection
2	IRJCT	IntegratoR JunCTion. Summing junction (negative input) of integrating amplifier.
3	VREF	Voltage REFerence Input
4	IRIN	IntegratoR INput. External integrator input R is connected between IRJCT and IRIN.
5	AIN	Analog INput. Unknown analog input voltage to be measured. Full-scale AIN equals VREF/2.125.
6	IROUT	IntegratoR OUTput. External integrating capacitor C is connected between IROUT and IRJCT.
7	VREF/2	Voltage REFerence ÷ 2 Input
8	AGND	Analog GrouND
9	VSS	Negative Supply (−5V to −12V)
10	NC	No Connection
11	NC	No Connection
12	NC	No Connection
13	NC	No Connection
14	STRT	STaRT Conversion. When STRT goes to a logic "1," the AD7550's digital logic is set up and BUSY is latched ""high." When STRT returns "low," conversion begins in synchronization with CLK. Reinitiating STRT during conversion causes a conversion restart. STRT can be driven from an external logic source, or can be programmed for continuous conversion by connecting an external capacitor between STRT and DGND. An externally applied STRT command must be a positive pulse of at least 800 nanoseconds to ensure proper set-up of the AD7550 logic.
15	CLK	CLocK Input. The CLK can be driven from external logic, or can be programmed for internal oscillation by connecting an external capacitor between CLK and DGND.
16	COUT	Count OUT provides a number (N) of gated clock pulses given by: $N = \left(\frac{AIN}{VREF} \quad 2.125 + 1\right) \quad 4096$
17	CIN	Count IN is the input to the output counter. 2's complement binary data appears on the DB0 through DB12 output lines (if the HBEN and LBEN enable lines are "high") if COUT is connected to CIN.

PIN	MNEMONIC	DESCRIPTION
18	HBEN	High Byte ENable is the three-state logic enable input for the DB8–DB12 data outputs. When HBEN is low, the DB8–DB12 outputs are floating. When HBEN is "high," digital data appears on the data lines.
19	LBEN	Low Byte ENable is the three-state logic enable for DB0–DB7. When LBEN is "low," DB0–DB7 are floating. When "high," digital data appears on the data lines.
20	DGND	Digital GrouND is the ground return for all digital logic and the comparator.
21	DB0	Data Bit 0 (least significant bit)
22	DB1	
23	DB2	
24	DB3	
25	DB4	
26	DB5	
27	DB6	CODE: 2's Complement
28	DB7	
29	DB8	
30	DB9	
31	DB10	
32	DB11	
33	DB12	Data Bit 12 (most significant bit)
34	OVRG	OVer Range indicates a logic "1" if AIN exceeds plus or minus full scale by at least 1/2 LSB. OVRG is a three-state output and floats until STEN is addressed with a logic "1."
35	$\overline{BUSY}$	Not BUSY. $\overline{BUSY}$ indicates whether conversion is complete or in progress. $\overline{BUSY}$ is a three-state output which floats until STEN is addressed with a logic "1." When addressed, $\overline{BUSY}$ will indicate either a "1" (conversion complete) or a "0" (conversion in progress).
36	BUSY	BUSY indicates conversion status. BUSY is a three-state output which floats until STEN is addressed with a logic "1." When addressed, BUSY indicates a "0" (conversion complete) or a "1" (conversion in progress.)
37	STEN	STatus ENable is the three-state control input for BUSY, $\overline{BUSY}$, and OVRG.
38	NC	No Connection
39	VCC	Logic Supply. Digital inputs and outputs are TTL compatible if VCC = +5V, CMOS compatible for VCC = +5V to VDD,
40	VDD	Positive Supply. +5V to +12V.

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ANALOG DEVICES

CMOS 10-Bit Monolithic A/D Converter

AD7570

FEATURES

- 8 and 10-Bit Resolution
- 20μsec Conversion Time
- Microprocessor Compatibility
- Very Low Power Dissipation
- Parallel and Serial Outputs
- Ratiometric Operation
- TTL/DTL/CMOS Logic Compatibility
- CMOS Monolithic Construction

GENERAL DESCRIPTION

The AD7570 is a monolithic CMOS 10-bit successive approximation A/D converter on a 120 by 135 mil chip, requiring only an external comparator, reference and passive clocking components. Ratiometric operation is inherent, since an extremely accurate multiplying DAC is used in the feedback loop.

The AD7570 parallel output data lines and Busy line utilize three-state logic to permit bussing with other A/D output and control lines or with other I/O interface circuitry. Two enables are available, one controls the two MSB's, the second controls the remaining 8 LSB's. This feature provides the control interface for most microprocessors which can accept only an 8-bit byte.

The AD7570 also provides a serial data output line to be used in conjunction with the serial synchronization line. The clock can be driven externally or, with the addition of a resistor and a capacitor, can run internally as high as 0.6 MHz allowing a total conversion time (8-bits) of typically 20μsec. An 8-bit short cycle control pin stops the clock after exercising 8 bits, normally used for the "J" version (8-bit resolution).

The AD7570 requires two power supplies, a +15V main supply and a +5V (for TTL/DTL logic) to +15V (for CMOS logic) supply for digital circuitry. Both analog and digital grounds are available.

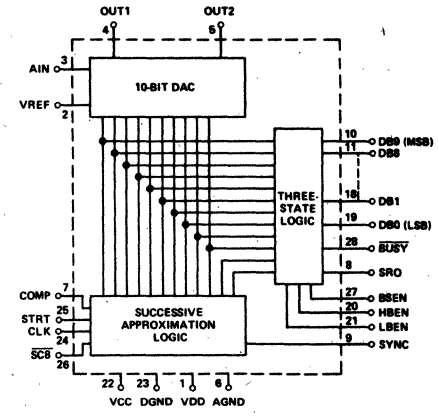
The AD7570 is a monolithic device using a proprietary CMOS process featuring a double layer metal interconnect, on-chip thin-film resistor network and silicon nitride passivation ensuring high reliability and excellent long term stability.

ORDERING INFORMATION

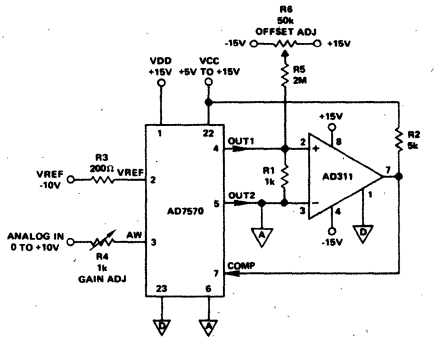
Resolution	Temperature Range	Price
	−25°C to +85°C	(100 Pcs)
8-Bit	AD7570J	$24.00
10-Bit	AD7570L	$49.00

Suffix D: Ceramic Package

FUNCTIONAL DIAGRAM

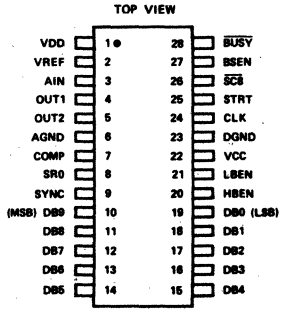


TYPICAL APPLICATION



NOTE:
IF POSITIVE VREF IS USED, THE ANALOG INPUT RANGE IS 0 TO -VREF, AND THE COMPARATOR'S (-) INPUT SHOULD BE CONNECTED TO OUT1 (PIN 4) OF THE AD7570.

PIN CONFIGURATION



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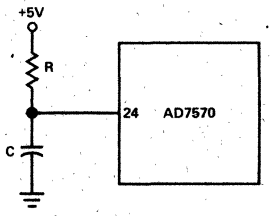
Pin Function Description

INPUT CONTROLS

1. Convert Start (pin 25 – STRT)
   When the start input goes to logical 1, the MSB data latch is set to logic 1 and all other data latches are set to logic 0. When the start input returns low, the conversion sequence begins. The start command must remain high for at least 500 nanoseconds. If a start command is reinitiated *during* conversion, the conversion sequence starts over.
2. High Byte Enable (pin 20 – HBEN)
   This is a three-state enable for the bit-9 (MSB) and bit 8. When the control is low, the output data lines for bits 9 and 8 are floating. When the control is high, digital data from the latches appears on the data lines.
3. Low Byte Enable (pin 21 – LBEN)
   Same as High Byte Enable pin, but controls bits 0 (LSB) through 7.
4. Busy Enable (pin 27 – BSEN)
   This is an interrogation input which requests the status of the converter, i.e., conversion in process or convert complete. The converter status is addressed by applying a logic 1 to the Busy Enable. (See Busy under Output Functions.)
5. Short Cycle 8-Bits (pin 26 – $\overline{SC8}$)
   With a logic 0 input, the conversion stops after 8 bits reducing the conversion time by 2 clock periods. This control should be exercised for proper operation of the "J" version. When a logic 1 is applied, a complete 10-bit conversion takes place ("L" version).
6. Clock(pin 24 – CLK)
   With an external RC connected, as shown in the Figure below, clock activity begins upon receipt of a Convert-Start command to the A/D, and ceases upon completion of conversion. An external clock (CMOS or TTL/DTL levels) can directly drive the clock terminals, if required. Figure 2 shows the internal CLK frequency versus R and C. If VCC is less than 4.75V, the internal CLK will not operate.



Generating Internal Clock Frequency

7. VDD (pin 1)
   VDD is the positive supply for all analog circuitry plus some digital logic circuits that are not part of the TTL compatible input/output lines (back-gates to the P-channel devices). Nominal supply voltage is +15V.
8. VCC (pin 22)
   VCC is the logic power supply. If +5V is used, all control inputs/outputs (with the exception of comparator terminal) are DTL/TTL compatible. If +15V is applied, control inputs/outputs are CMOS compatible.

OUTPUT FUNCTIONS

1. Busy (pin 28 – $\overline{BUSY}$)
   The Busy line indicates whether conversion is complete or in process. Busy is a three-state output and floats until the Busy-Enable line is addressed with a logic 1. When addressed, Busy will indicate either a 1 (conversion complete) or a 0 (conversion in process).
2. Serial Output (pin 8 – SRO)
   Provides output data in serial format. Data is available only during conversion. When the A/D is not converting, the Serial Output line "floats." The Serial Sync (see next function) *must* be used, along with the Serial Output terminal to avoid misinterpreting data.
3. Serial Synchronization (pin 9 – SYNC)
   Provides 10 positive edges, which are synchronized to the Serial Output pin. Serial Sync is floating if conversion is not taking place.

Note that all digital inputs/outputs are TTL/DTL compatible when VCC is +5V, and CMOS compatible when VCC is +15V.

Table 1. Function Table

PIN NO.	MNEMONIC	FUNCTION
1	VDD	Positive Supply (+15V)
2	VREF	Voltage REFerence (±10V)
3	AIN	Analog INput
4	OUT1	DAC Current OUTput 1
5	OUT2	DAC Current OUTput 2
6	AGND	Analog GrouND
7	COMP	COMParator
8	SRO	SeRial Output
9	SYNC	Serial SYNChronization
10	DB9	Data Bit 9 (MSB)
11	DB8	Data Bit 8
12	DB7	Data Bit 7
13	DB6	Data Bit 6
14	DB5	Data Bit 5
15	DB4	Data Bit 4
16	DB3	Data Bit 3
17	DB2	Data Bit 2
18	DB1	Data Bit 1
19	DB0	Data Bit 0 (LSB)
20	HBEN	High Byte ENable
21	LBEN	Low Byte ENable
22	VCC	Logic Supply (+5V to +15V)
23	DGND	Digital GrouND
24	CLK	CLocK
25	STRT	STaRT
26	$\overline{SC8}$	Short Cycle 8 Bits
27	BSEN	BuSy ENable
28	$\overline{BUSY}$	BUSY

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ANALOG DEVICES

DI CMOS Protected Analog Switches

AD7510DI, AD7511DI, AD7512DI

FEATURES

- Latch-Proof
- Overvoltage-Proof: ±25V
- Low R_{ON}: 75Ω
- Low Dissipation: 3 mW
- TTL/CMOS Direct Interface
- Silicon-Nitride Passivated
- Monolithic Dielectrically-Isolated CMOS

GENERAL DESCRIPTION

The AD7510DI, AD7511DI and AD7512DI are a family of latch proof dielectrically isolated CMOS switches featuring overvoltage protection up to ±25V above the power supplies. These benefits are obtained without sacrificing the low "ON" resistance (75Ω) or low leakage current (400 pA), the main features of an analog switch.

The AD7510DI and AD7511DI consist of four independent SPST analog switches packaged in a 16-pin DIP. They differ only in that the digital control logic is inverted. The AD7512DI has two independent SPDT switches packaged in a 14-pin DIP.

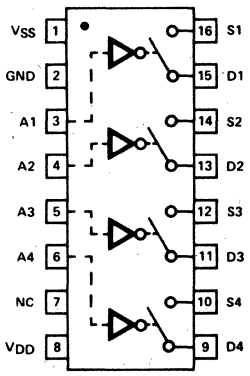
Very low power dissipation, overvoltage protection and TTL/CMOS direct interfacing are achieved by combining a unique circuit design and a dielectrically isolated CMOS process. Silicon nitride passivation ensures long term stability while monolithic construction provides reliability.

PRICE INFORMATION

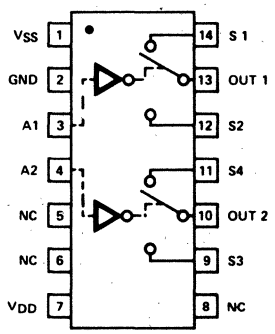
Model	Price (100 Pcs)	Model	Price (100 Pcs)
AD7510DIJN	$ 5.80	AD7510DIKN	$ 6.40
AD7511DIJN	5.80	AD7511DIKN	6.40
AD7512DIJN	5.80	AD7512DIKN	6.40
AD7510DIJD	$10.00	AD7510DIKD	$11.00
AD7511DIJD	10.00	AD7511DIKD	11.00
AD7512DIJD	10.00	AD7512DIKD	11.00
AD7510DISD	$16.00	AD7510DITD	$18.00
AD7511DISD	16.00	AD7511DITD	18.00
AD7512DISD	16.00	AD7512DITD	18.00

PIN CONFIGURATIONS

AD7510DI
AD7511DI



AD7512DI



CONTROL LOGIC

AD7510DI: Switch "ON" for Address "HIGH"

AD7511DI: Switch "ON" for Address "LOW"

AD7512DI: Address "HIGH" makes S1 to Out-1 and S3 to Out-2

ORDERING INFORMATION

PLASTIC (SUFFIX N)	CERAMIC (SUFFIX D)	OPERATING TEMPERATURE RANGE
AD7510DIJN AD7510DIKN AD7511DIJN AD7511DIKN AD7512DIJN AD7512DIKN		0°C to +70°C
	AD7510DIJD AD7510DIKD AD7511DIJD AD7511DIKD AD7512DIJD AD7512DIKD	−25°C to +85°C
	AD7510DISD AD7511DISD AD7511DITD AD7512DISD AD7512DITD	−55°C to +125°C

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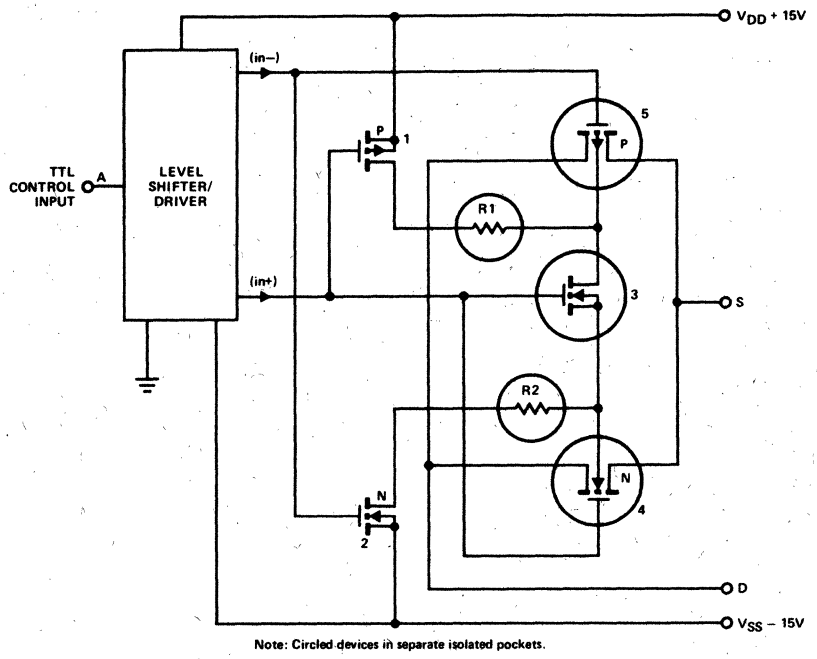

Figure 1. Typical Output Switch Circuitry of AD7510DI Series

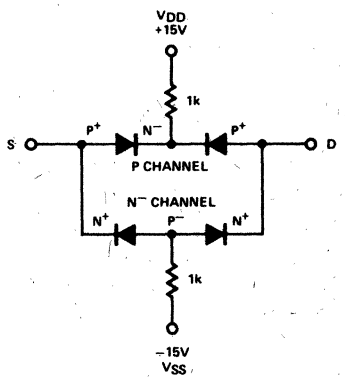

Figure 2. AD7510DI Series Output Switch Diode Equivalent Circuit

CIRCUIT DESCRIPTION

CMOS devices make excellent analog switches; however, problems with overvoltage and latch-up phenomenum necessitated protection circuitry. These protection circuits, however, either caused degradation of important switch parameters such as R_{ON} or leakage, or provided only limited protection in the event of overvoltage.

The AD7510DI series switches utilize a dielectrically-isolated CMOS fabrication process to eliminate the four-layer substrate found in junction-isolated CMOS, thus providing latch-free operation.

A typical switch channel is shown in Figure 1. The output switching element is comprised of device numbers 4 and 5. Operation is as follows: for an "ON" switch, (in+) is V_{DD} and (in–) is V_{SS} from the driver circuits. Device numbers 1 and 2 are "OFF" and number 3 is "ON." Hence, the back-gates of the P- and N-channel output devices (numbers 4 and 5) are tied together and floating. (The circled devices are located in separate dielectrically isolated pockets.) Floating the output switch back-gates with the signal input increases the effective threshold voltage for an applied analog signal, thus providing a flatter R_{ON} versus V_S response.

For an "OFF" switch, device number 3 is "OFF," and the back-gates of devices 4 and 5 are tied through 1 kΩ resistors (R1 and R2) to the respective supply voltages through the "ON" devices 1 and 2.

If a voltage is applied to the S or D terminal which exceeds V_{DD} or V_{SS}, the S- or D-to-back-gate diode is forward biased; however, R1 and R2 provide current limiting action.

Consequently, without external current limiting resistance (or increased R_{ON}), the AD7510DI series switches provide:

1. Latch-proof operation
2. Overvoltage protection 25V beyond the V_{SS} and V_{DD} supply voltage

An equivalent circuit of the output switch element in Figure 2 shows that, indeed, the 1 kΩ limiting resistors are in series with the back-gates of the P- and N-channel output devices—*not* in series with the signal path between the S and D terminals.

In some applications it is possible to turn on a parasitic NPN (drain to back-gate to source of the N-channel) transistor, causing device destruction under certain conditions. This case will only manifest itself when a negative overvoltage (and not a positive overvoltage) exists with another voltage source on the other side of the switch. Current limitation through external resistors (200Ω) or current limiting devices (output of op amps) will prevent damage to the device.

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ANALOG DEVICES

Monolithic Analog CMOS Switches

AD7513, AD7516, AD7519

AD7513

FEATURES

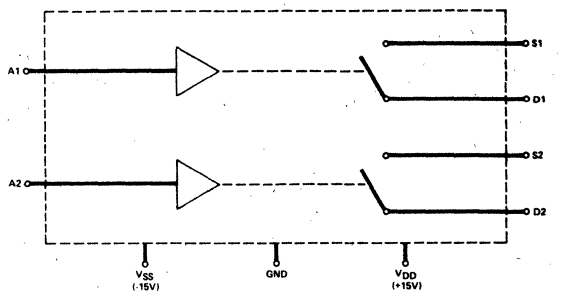
"ON" Resistance:	55Ω
Break-Before-Make Switching	
Power Dissipation:	3mW
DTL/TTL/CMOS Compatible	
Switch Current:	50mA
Replaces DG-200	

GENERAL DESCRIPTION

The AD7513 is composed of two independent single-pole-single-throw switches on a CMOS chip. State-of-the-art design provides TTL/DTL/CMOS compatibility and a low power dissipation of 3 mW.

The AD7513 is an excellent replacement for reed relays and FET switches due to its low power dissipation, direct logic interface capability and low price. Its high surge current capability makes it ideal for use in integrator or sample/hold circuits.

FUNCTIONAL DIAGRAM



LOGIC

Switch "ON" For Address "LOW".

AD7516

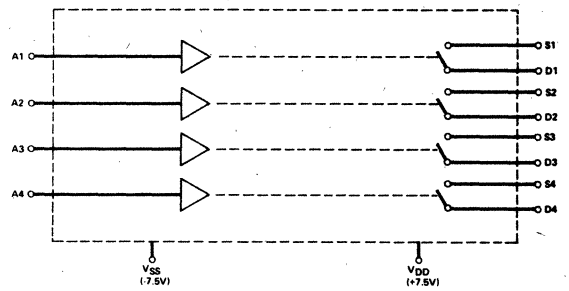
FEATURES

Low "ON" Resistance	100Ω
R_{ON} Mismatch Between Switches	1%
Fast Switching	20 ns
Low Power Dissipation	10μW, max.
Superior Replacement for:	
CD4016A (AD7516J, S) CD4066A (AD7516K, T)	

GENERAL DESCRIPTION

The AD7516 consists of four SPST switches on a monolithic CMOS chip. It is intended as a superior replacement for the CD4016A, and CD4066A offering improved R_{ON} characteristics. It is useful for fast switching of a wide range of digital or analog signal levels – digital or analog signals to 15 V peak and analog signals to ±7.5 V peak. It can be operated from balanced or unbalanced power supplies.

FUNCTIONAL DIAGRAM



LOGIC

Switch "ON" For Address "HIGH".

AD7519

FEATURES

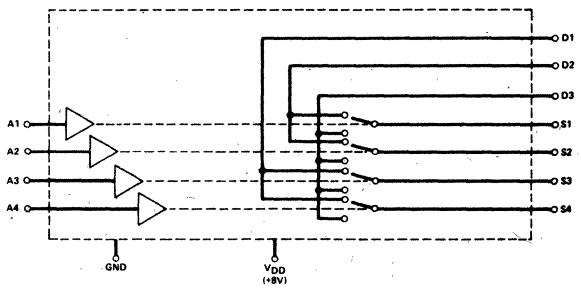
Low R_{ON}	65Ω
Low Power Dissipation	8.0μW
Fast Switching	20 ns
CMOS Compatible	

GENERAL DESCRIPTION

The AD7519 consists of four SPDT switches which steer current to one of two buss lines that normally should be terminated at ground or the virtual ground of an operational amplifier. It operates from a single +7.5 to +10 V supply with a quiescent power dissipation of only 8.0 μW.

Typical AD7519 applications include fast settling D/A converters, variable gain amplifiers, and digitally controlled summing amplifiers.

FUNCTIONAL DIAGRAM



LOGIC

Switch "Makes" Terminal D-3 for Address "HIGH"

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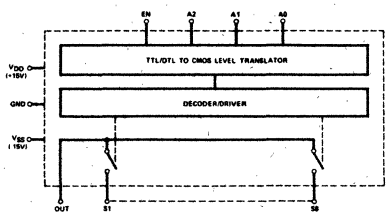
ANALOG DEVICES

Monolithic CMOS Multiplexers

AD7501, AD7502, AD7503, AD7506, AD7507

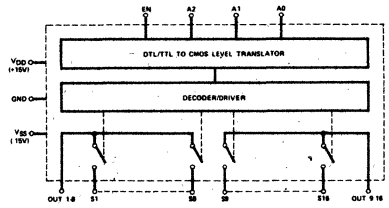
AD7501, AD7503
8-Channel MUX
TTL/DTL/CMOS Direct Interface
Output "Enable" Control
Power Dissipation: 30μW
AD7503 Replaces HI-1818



AD7501				
A_2	A_1	A_0	E_N	"ON"
0	0	0	1	1
0	0	1	1	2
0	1	0	1	3
0	1	1	1	4
1	0	0	1	5
1	0	1	1	6
1	1	0	1	7
1	1	1	1	8
X	X	X	0	None

AD7503				
A_2	A_1	A_0	E_N	"ON"
0	0	0	0	1
0	0	1	0	2
0	1	0	0	3
0	1	1	0	4
1	0	0	0	5
1	0	1	0	6
1	1	0	0	7
1	1	1	0	8
X	X	X	1	None

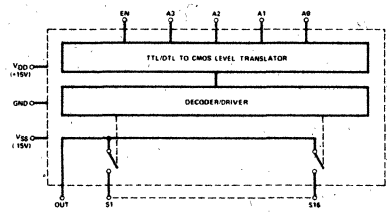
AD7502, AD7507
4- & 8-Channel Differential MUX
TTL/DTL/CMOS Direct Interface
Output "Enable" Control
AD7507 is superior plug-in replacement for DG-507



AD7502			
A_1	A_0	E_N	"ON"
0	0	1	1 & 5
0	1	1	2 & 6
1	0	1	3 & 7
1	1	1	4 & 8
X	X	0	None

AD7507				
A_2	A_1	A_0	E_N	"ON"
0	0	0	1	1 & 9
0	0	1	1	2 & 10
0	1	0	1	3 & 11
0	1	1	1	4 & 12
1	0	0	1	5 & 13
1	0	1	1	6 & 14
1	1	0	1	7 & 15
1	1	1	1	8 & 16
X	X	X	0	None

AD7506
16-Channel MUX
TTL/DTL/CMOS Direct Interface
Output "Enable" Control
Power Dissipation: 1.5 mW
Superior replacement for DG-506



AD7506					
A_3	A_2	A_1	A_0	E_N	"ON"
0	0	0	0	1	1
0	0	0	1	1	2
0	0	1	0	1	3
0	0	1	1	1	4
0	1	0	0	1	5
0	1	0	1	1	6
0	1	1	0	1	7
0	1	1	1	1	8
1	0	0	0	1	9
1	0	0	1	1	10
1	0	1	0	1	11
1	0	1	1	1	12
1	1	0	0	1	13
1	1	0	1	1	14
1	1	1	0	1	15
1	1	1	1	1	16
X	X	X	X	0	None

PERFORMANCE SELECTION TABLE (T_A = +25°C)

Parameter	Units	AD7501 Commercial	AD7503 Military[1]	AD7502 Commercial	AD7502 Military	AD7506 Commercial	AD7506 Military	AD7507 Commercial	AD7507 Military
R_{ON} (MAX)	ohms	300		300		450	400	450	400
I_S (MAX)	nA	2	0.5	2	0.5	5	1	5	1
I_{OUT} (MAX)	nA	10	5	5	3	20	10	10	5
$t_{transition}$ (TYP)	μs	0.8		0.8		0.7		0.7	
I_{DD}[2] (MAX)	mA	0.5	0.8	0.5	0.8	1		1	
I_{SS}[2] (MAX)	mA	0.1	0.8	0.1	0.8	1		1	

NOTES: [1] "Commercial" and "Military" refer to operating temperature ranges.
[2] For all digital inputs high (worst case).

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Analog CMOS MULTIPLEXERS

FUNCTION	DEVICE	FEATURE	TTL "HIGH" MIN(V)	$R_{ON}(\Omega)$ (TYP)	$I_{D(OFF)}$ (NA) (TYP)	t(ON) (NS) (TYP)	t(OFF) (NS) (TYP)	P_D(mW) (TYP)
4-CHANNEL DIFFERENTIAL	HI-1828A	LOW R_{ON} LOW LEAKAGE	4.0	250	0.05	350	250	5
	HI-509A	ANALOG INPUT OVERVOLTAGE PROTECTION	4.0	1200	1.0	500	420	7.5
8-CHANNEL	HI-1818A	LOW R_{ON} LOW LEAKAGE	4.0	250	0.1	350	250	5
	HI-508A	ANALOG OVERVOLTAGE PROTECTION	4.0	1200	1.0	500	420	7.5
8-CHANNEL DIFFERENTIAL	HI-507	LOW R_{ON}	2.4	170	1.0	300	220	30
	HI-507A	ANALOG OVERVOLTAGE PROTECTION	4.0	1200	1.0	500	420	7.5
16-CHANNEL	HI-506	LOW R_{ON}	2.4	170	1.0	300	220	30
	HI-506A	ANALOG OVERVOLTAGE PROTECTION	4.0	1200	1.0	500	420	7.5
	HI-1840	HIGH-Z OVERVOLTAGE PROTECTION	4.0	2000	1.0	500	420	0.6

NOTE: All data typical room temperature specifications at ± 15V supplies.

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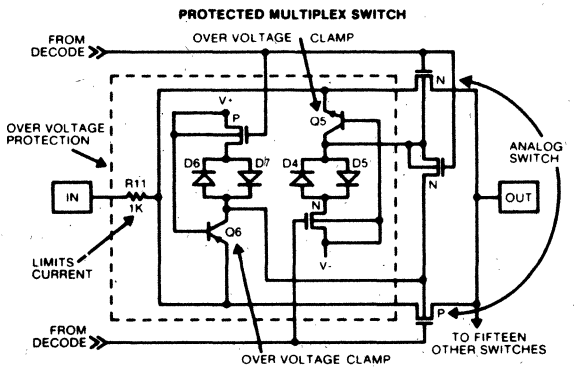

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Analog CMOS SWITCHES

FUNCTION	DEVICE	$R_{ON}(\Omega)$ (TYP)	$I_{D(OFF)}$(NA) (TYP)	$t_{(ON)}$(NS) (TYP)	$t_{(OFF)}$(NS) (TYP)	P_D(mW) (TYP)
5PST	HI-5040	50	0.5	370	280	1.5
2 x SPST	HI-200	55	1	240	180	15
	HI-5048	25	0.5	370	280	1.5
	HI-5041	50	0.5	370	280	1.5
4 x SPST	HI-201	65	2	180	155	15
SPDT	HI-5050	25	0.5	370	280	1.5
	HI-5042	50	0.5	370	280	1.5
2 x SPDT	HI-5051	25	0.5	370	280	1.5
	HI-5043	50	0.5	370	280	1.5
DPST	HI-5044	50	0.5	370	280	1.5
2 x DPST	HI-5049	25	0.5	370	280	1.5
	HI-5045	50	0.5	370	280	1.5
2 x DPST (3 ADDRESS)	HI-1800A	125	0.02	500	300	10
DPDT	HI-5046A	25	0.5	370	280	1.5
	HI-5046	50	0.5	370	280	1.5
4PST	HI-5047A	25	0.5	370	280	1.5
	HI-5047	50	0.5	370	280	1.5

NOTE: All data typical room temperature specifications at ± 15V supplies.

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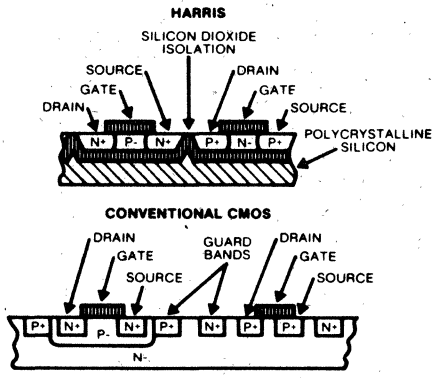

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DP/INS4201 clock generator

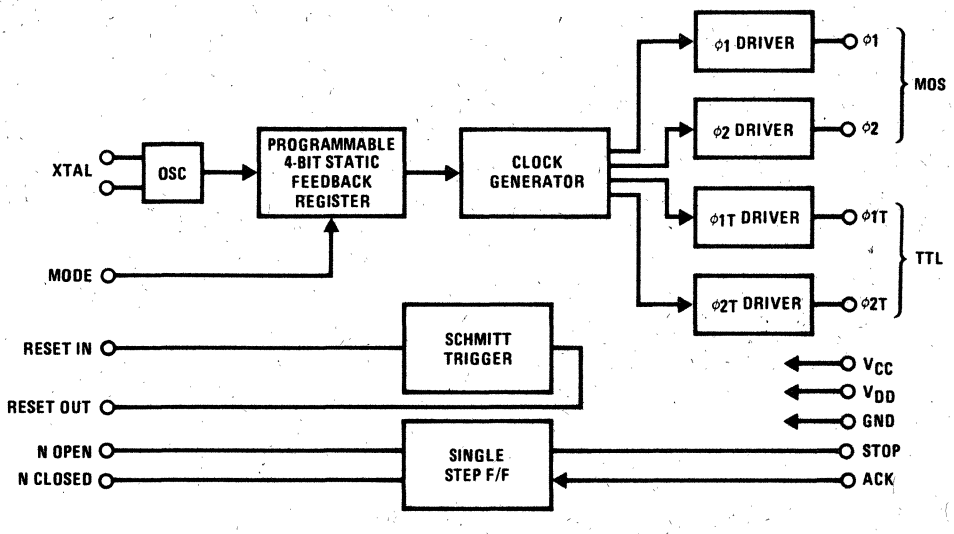
general description

The DP4201 Clock Generator is designed for 4004 micro-computer series family applications, and satisfies clock signal requirements MCS-40™ and FIPS (4-Bit Integrated Processing System) micro-computer devices. An externally crystal controlled oscillator is required for generation of TTL and MOS level clock signals. Power "ON" or external reset may be accomplished with the DP4201. A single step feature also exists.

features

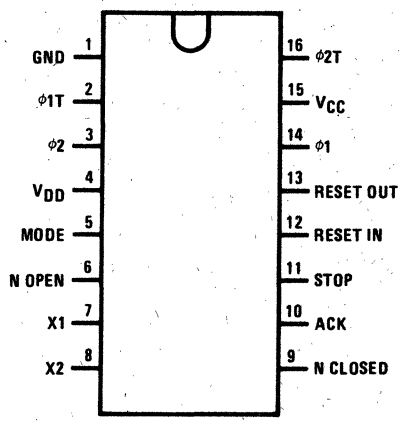
- Satisfies clock requirements for FIPS and MCS-40
- Crystal controlled oscillator
- MOS and TTL level clock outputs
- Power "ON" and external reset control
- Operative frequency from dc to 6 MHz

block diagram



connection diagram

Dual-In-Line Package



TOP VIEW

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ac electrical characteristics

$T_A = 0°C$ to $+70°C$, $V_{CC} - V_{DD} = 15V \pm 5\%$, Gnd = $V_{CC} - 5V \pm 5\%$, $1.35\ ns \leq t_{cy} \leq 2\mu s$

PARAMETER		CONDITIONS	MIN	TYP	MAX	UNITS
t_{cy}	Clock Period	Mode = V_{CC}		$t_{XTAL} \times 7$		ns
$t_{\phi PW}$	Clock Pulse Width	Mode = V_{CC}	$(2/7)t_{cy}-10$	$(2/7)t_c$	$(2/7)t_{cy}+10$	ns
$t_{\phi D1}$	Clock Delay From ϕ_1 to ϕ_2	Mode = V_{CC}	$(2/7)t_{cy}-10$	$(2/7)t_{cy}$	$(2/7)t_{cy}+10$	ns
$t_{\phi D2}$	Clock Delay From ϕ_2 to ϕ_1	Mode = V_{CC}	$(1/7)t_{cy}-10$	$(1/7)t_{cy}$	$(1/7)t_{cy}+10$	ns
t_{cy}	Clock Period	Mode = V_{DD}		$t_{XTAL} \times 8$		ns
$t_{\phi PW}$	Clock Pulse Width	Mode = V_{DD}	$(1/4)t_{cy}-10$	$(1/4)t_{cy}$	$(1/4)t_{cy}+10$	ns
$t_{\phi D1}$	Clock Delay From ϕ_1 to ϕ_2	Mode = V_{DD}	$(1/4)t_{cy}-10$	$(1/4)t_{cy}$	$(1/4)t_{cy}+10$	ns
$t_{\phi D2}$	Clock Delay From ϕ_2 to ϕ_1	Mode = V_{DD}	$(1/4)t_{cy}-10$	$(1/4)t_{cy}$	$(1/4)t_{cy}+10$	ns
$t_{\phi D3}$	TTL Clock to MOS Clock Skew		0	20	40	ns
$t_{\phi r}, t_{\phi f}$	Clock Rise and Fall Time	C_L = 300 pF = ϕ_1, ϕ_2 C_L = 50 pF = ϕ_{1T}, ϕ_{2T}		25	50	ns
t_D	Delay From ACK to Stop	C_L = 20 pF		60	500	ns

pin description

Pin No.	Designation	Description of Function
1	GND	Circuit ground potential. This pin can be left floating for low power application. MOS clock output will be operative. TTL clock outputs will not.
2	ϕ_{1T}	Phase 1. TTL level clock output. Positive true.
3	ϕ_2	Phase 2. MOS level clock output.
4	V_{DD}	Main power supply pin. $V_{DD} = V_{CC} - 15V \pm 5\%$.
5	MODE	Counter mode control pin. Determines whether counter divides basic frequency by 8 or 7. Mode = V_{CC}; ÷7 Mode = V_{DD}; ÷8
6	N. OPEN	Input of single step circuitry to which normally open contact of SPDT switch is connected.
7	X1	External crystal connection. This pin may be driven by an external frequency source. X2 should be left unconnected.
8	X2	External crystal connection.
9	N. CLOSED	Input of single step circuitry to which normally closed contact of SPDT switch is connected.
10	ACK	Acknowledge input to single step circuitry normally connected to stop acknowledge output of 4004.
11	STOP	Stop output of single step circuitry normally connected to stop input of 4004. A SPDT toggle switch may be inserted in this line for RUN/HALT control.
12	RESET IN	Input to which RC network is connected to provide power on reset timing.
13	RESET OUT	This signal is active low.
14	ϕ_1	Phase 1 MOS level clock output.
15	V_{CC}	Circuit reference potential—most positive supply voltage.
16	ϕ_{2T}	Phase 2. TTL level clock output. Positive true.

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absolute maximum ratings (Note 1)

$V_{CC} - V_{DD}$ dc Supply Voltage	−0.5 to +18 V_{DC}
V_{IN} Input Voltage	V_{DD} − 0.3 to V_{CC} + 0.5 V_{DC}
T_S Storage Temperature Range	−65°C to +150°C
P_D Package Dissipation	500 mW
T_L Lead Temperature (Soldering, 10 seconds)	300°C

recommended operating conditions

$V_{CC} - V_{DD}$ dc Supply Voltage	15 V_{DC}
V_{CC} − Gnd dc Supply Voltage	5 V_{DC}
V_{IN} Input Voltage	V_{DD} to V_{CC}
T_A Operating Temperature Range	0°C to +70°C

dc electrical characteristics $T_A = 0°C$ to +70°C, $V_{CC} - V_{DD} = 15V \pm 5\%$, Gnd = $V_{CC} - 5V \pm 5\%$

	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current (Measurement in V_{CC} Pin)	Static Operation, Pin 6, Pin 9 = V_{CC}, Pin 12, Pin 10 = V_{DD}, Pin 7 = V_{CC}			300	μA
		Dynamic Operation, 5.185 MHz Crystal, C_L = 20 pF, ϕ_1 and ϕ_2			25	mA
I_{L1}	Input Leakage Current	$V_{IL} = V_{DD}$, All Inputs Except X1, X2, N. Open, N. Closed			1	μA
V_{IH}	Input High Voltage	All Inputs Except X1, X2, Reset	V_{CC}−1.5		V_{CC}+0.5	V
V_{IL}	Input Low Voltage	All Inputs Except X1, X2, Reset	V_{DD}		V_{CC}−13	V
V_{OH}	Output High Voltage	Capacitive Load Only	V_{CC}−1.5		V_{CC}	V
V_{OL}	Output Low Voltage	Capacitive Load Only	V_{DD}		V_{CC}−13.4	V
V_{OH}	ϕ_{1T}, ϕ_{2T}, Output High Voltage	I_{OH} = −400μA	V_{CC}−0.75			V
V_{OL}	ϕ_{1T}, ϕ_{2T} Output Low Voltage	I_{OL} = 1.6 mA			Gnd+0.5	V
I_{OL}	ϕ_1, ϕ_2 Sink Current	$V_{OUT} = V_{CC}$, Pulse Width ≤ 1μs	400			mA
I_{OH}	ϕ_1, ϕ_2 Source Current	$V_{OUT} = V_{DD}$	180			mA
I_{OL}	ϕ_{1T}, ϕ_{2T} Sink Current	$V_{OUT} = V_{CC}$	15			mA
I_{OH}	ϕ_{1T}, ϕ_{2T} Source Current	$V_{OUT} = V_{DD}$	8			mA
I_{OL}	Reset Sink Current	$V_{OUT} = V_{CC}$	6			mA
I_{OH}	Reset Source Current	$V_{OUT} = V_{DD}$	6			mA
I_{OL}	Stop Sink Current	$V_{OUT} = V_{CC}$	1			mA
I_{OH}	Stop Source Current	$V_{OUT} = V_{DD}$	1			mA
V_{IL}	Reset Input Low Voltage		V_{DD}		V_{CC}−11	V
V_{IH}	Reset Input High Voltage		V_{CC}−6.5		V_{CC}+0.5	V
R_I	Pull-Up Resistance on N. Open, N. Closed	$V_{IN} = V_{DD}$	20		120	kΩ
C_{IN}	Input Capacitance	All Inputs Except X1, X2		5		pF

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed; they are not meant to imply that the devices should be operated at these limits. The table of "Recommended Operating Conditions" and "Electrical Characteristics" provides conditions for actual device operation.

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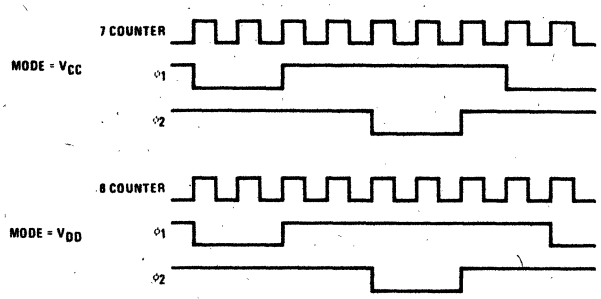
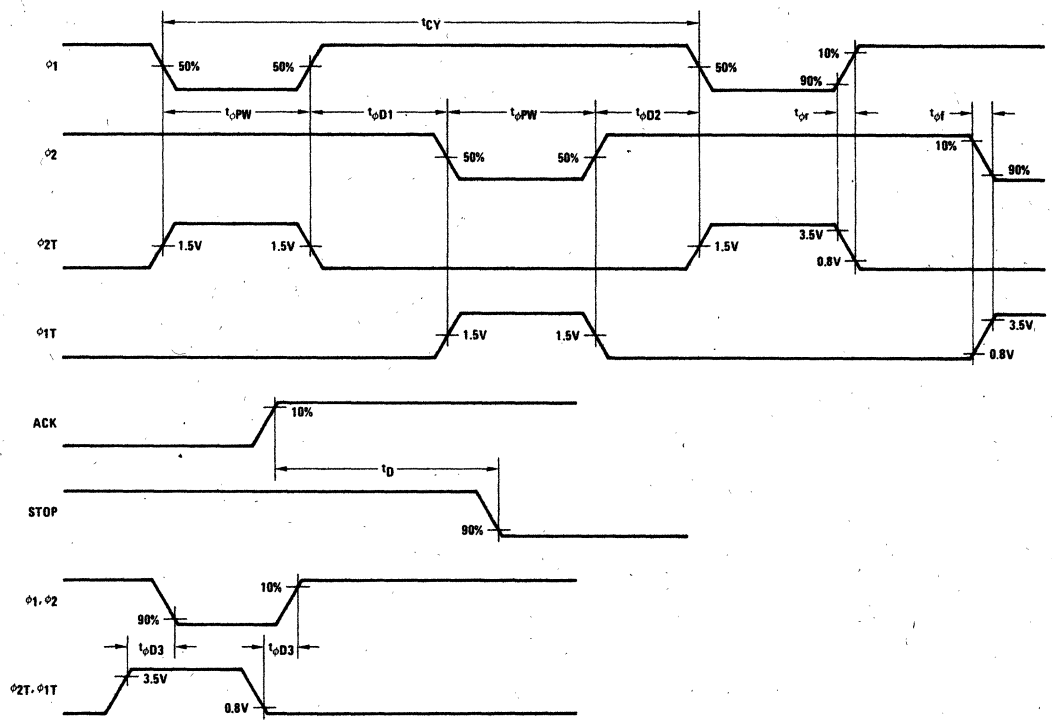
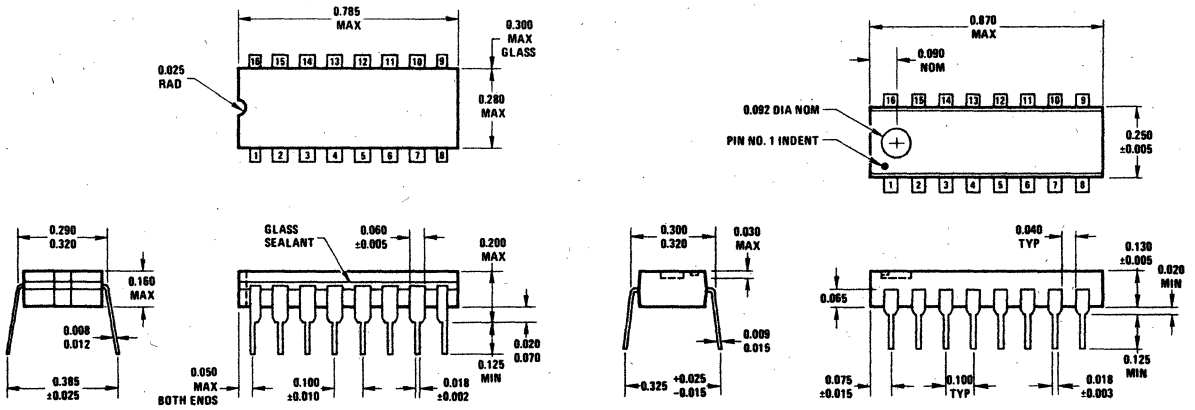
timing diagrams



switching time waveforms



physical dimensions



Cavity Dual-In-Line Package (J)
Order Number DP4201J

Molded Dual-In-Line Package (N)
Order Number DP4201N

Manufactured under one or more of the following U.S. patents: 3083262, 3189758, 3231797, 3303356, 3317671, 3323071, 3381071, 3408542, 3421025, 3426423, 3440498, 3518750, 3519897, 3557431, 3560765, 3566218, 3571630, 3575609, 3579059, 3593069, 3597640, 3607469, 3617859, 3631312, 3633052, 3638131, 3648071, 3651565, 3693248.

National Semiconductor Corporation
2900 Semiconductor Drive, Santa Clara, California 95051, (408) 737-5000/TWX (910) 339-9240
National Semiconductor GmbH
808 Fuerstenfeldbruck, Industriestrasse 10, West Germany, Tele. (08141) 1371/Telex 05-27649
National Semiconductor (UK) Ltd.
Larkfield Industrial Estate, Greenock, Scotland, Tele. (0475) 33251/Telex 778-632

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National Semiconductor

DP8212 8-Bit Input/Output Port

general description

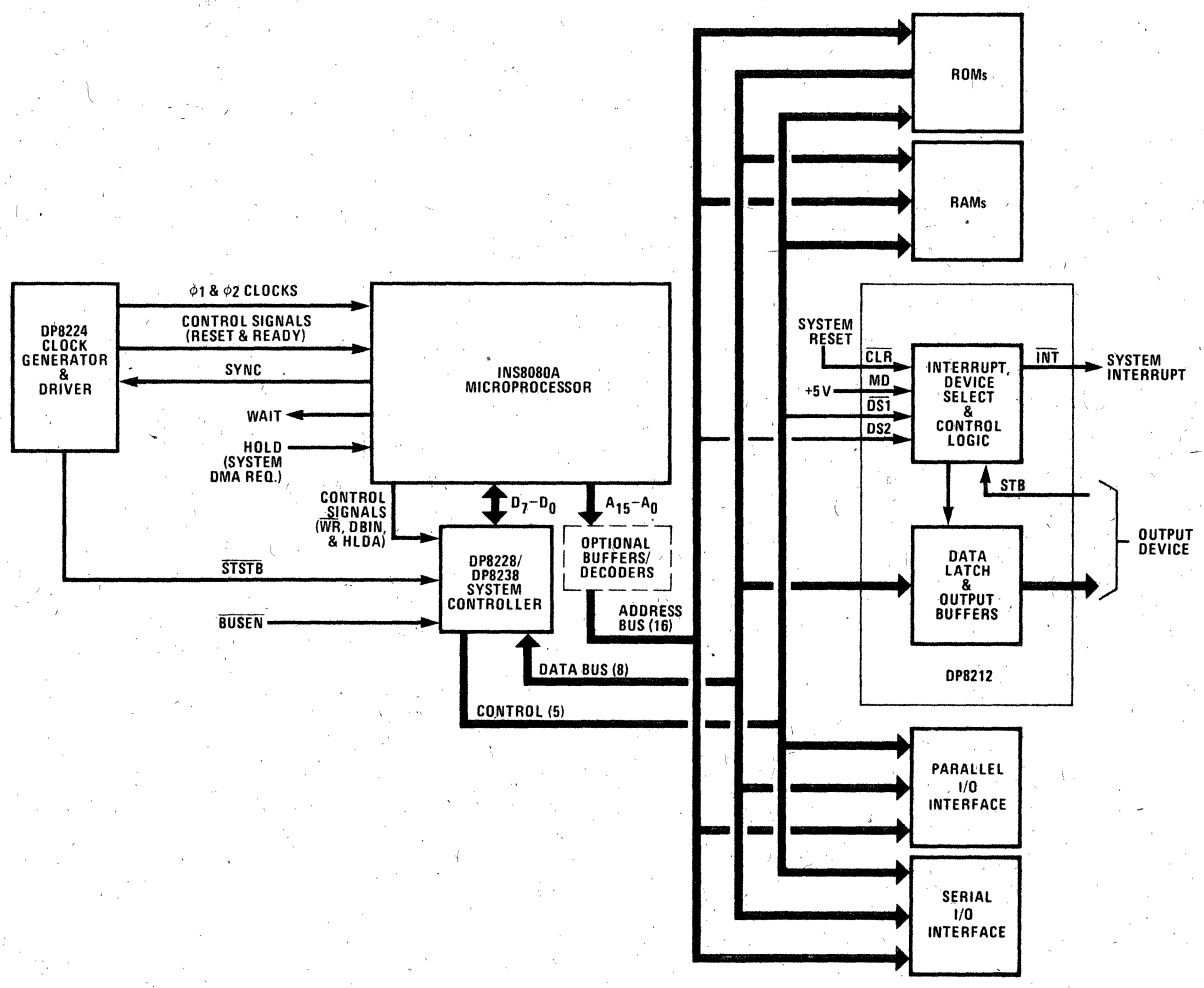
The DP8212 is an 8-bit input/output port contained in a standard 24-pin dual-in-line package. The device, which is fabricated using Schottky Bipolar technology, is part of National Semiconductor's N8080 microcomputer family. The DP8212 can be used to implement latches, gated buffers, or multiplexers. Thus, all of the major peripheral and input/output functions of a microcomputer system can be implemented with this device.

The DP8212 includes an 8-bit latch with TRI-STATE® output buffers, and device selection and control logic. Also included is a service request flip-flop for the generation and control of interrupts to the microprocessor.

features

- 8-Bit Data Latch and Buffer
- Service Request Flip-flop for Generation and Control of Interrupts
- 0.25mA Input Load Current
- TRI-STATE TTL Output Drive Capability
- Outputs Sink 15mA
- Asynchronous Latch Clear
- 3.65V Output for Direct Interface to INS8080A
- Reduces System Package Count by Replacing Buffers, Latches, and Multiplexers in Microcomputer Systems

N8080A microcomputer family block diagram



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absolute maximum ratings

Temperature Under Bias Plastic . . . . . −65°C to +75°C
Storage Temperature . . . . . −65°C to +160°C
All Output or Supply Voltages. . . . . −0.5V to +7V
All Input Voltages. . . . . −1.0V to 5.5V
Output Currents 125mA

Note: Maximum ratings indicate limits beyond which permanent damage may occur. Continuous operation at these limits is not intended and should be limited to those conditions specified under dc electrical characteristics.

dc electrical characteristics

$T_A = 0°C$ to $+75°C$, $V_{CC} = +5V \pm 5\%$

Symbol	Parameter	Limits			Unit	Test Conditions
		Min.	Typ.	Max.		
I_F	Input Load Current STB, DS_2, $\overline{CLR}$, DI_1-DI_8 Inputs			−0.25	mA	$V_F = 0.45V$
I_F	Input Load Current MD Input			−0.75	mA	$V_F = 0.45V$
I_F	Input Load Current $\overline{DS_1}$ Input			−1.0	mA	$V_F = 0.45V$
I_R	Input Leakage Current STB, DS_2, $\overline{CLR}$, DI_1-DI_8 Inputs			10	μA	$V_R = 5.25V$
I_R	Input Leakage Current MD Input			30	μA	$V_R = 5.25V$
I_R	Input Leakage Current $\overline{DS_1}$ Input			40	μA	$V_R = 5.25V$
V_C	Input Forward Voltage Clamp			−1	V	$I_C = -5mA$
V_{IL}	Input "Low" Voltage			0.85	V	
V_{IH}	Input "High" Voltage	2.0			V	
V_{OL}	Output "Low" Voltage			0.45	V	$I_{OL} = 15mA$
V_{OH}	Output "High" Voltage	3.65	4.0		V	$I_{OH} = -1mA$
I_{SC}	Short Circuit Output Current	−15		−75	mA	$V_O = 0V$
$\|I_O\|$	Output Leakage Current High Impedance State			20	μA	$V_O = 0.45V/5.25V$
I_{CC}	Power Supply Current		90	130	mA	

capacitance*

$F = 1MHz$, $V_{BIAS} = 2.5V$, $V_{CC} = +5V$, $T_A = 25°C$

Symbol	Test	Limits	
		Typ.	Max.
C_{IN}	DS_1, MD Input Capacitance	9pF	12pF
C_{IN}	DS_2, $\overline{CLR}$, STB, DI_1-DI_8 Input Capacitance	5pF	9pF
C_{OUT}	DO_1-DO_8 Output Capacitance	8pF	12pF

*This parameter is sampled and not 100% tested.

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ac electrical characteristics

$T_A = 0°C$ to $+75°C$, $V_{CC} = +5V \pm 5\%$

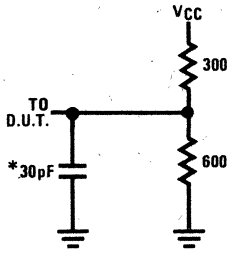
Symbol	Parameter	Limits			Units	Test Conditions
		Min.	Typ.	Max.		
t_{PW}	Pulse Width	30			ns	
t_{PD}	Data to Output Delay			30	ns	
t_{WE}	Write Enable to Output Delay			40	ns	
t_{SET}	Data Setup Time	15			ns	
t_H	Data Hold Time	20			ns	
t_R	Reset to Output Delay			40	ns	
t_S	Set to Output Delay			30	ns	
t_E	Output Enable/Disable Time			45	ns	
t_C	Clear to Output Delay			55	ns	

switching characteristics

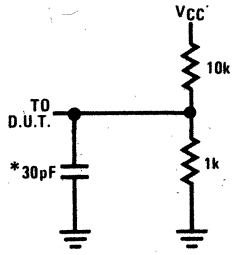
Conditions of Test:

1. Input Pulse Amplitude = 2.5V.
2. Input Rise and Fall Times = 5ns.
3. Between 1V and 2V Measurements made at 1.5V with 15mA & 30pF Test Load.

Test Load
15mA & 30pF



Alternate Test Load



*including jig & probe capacitance

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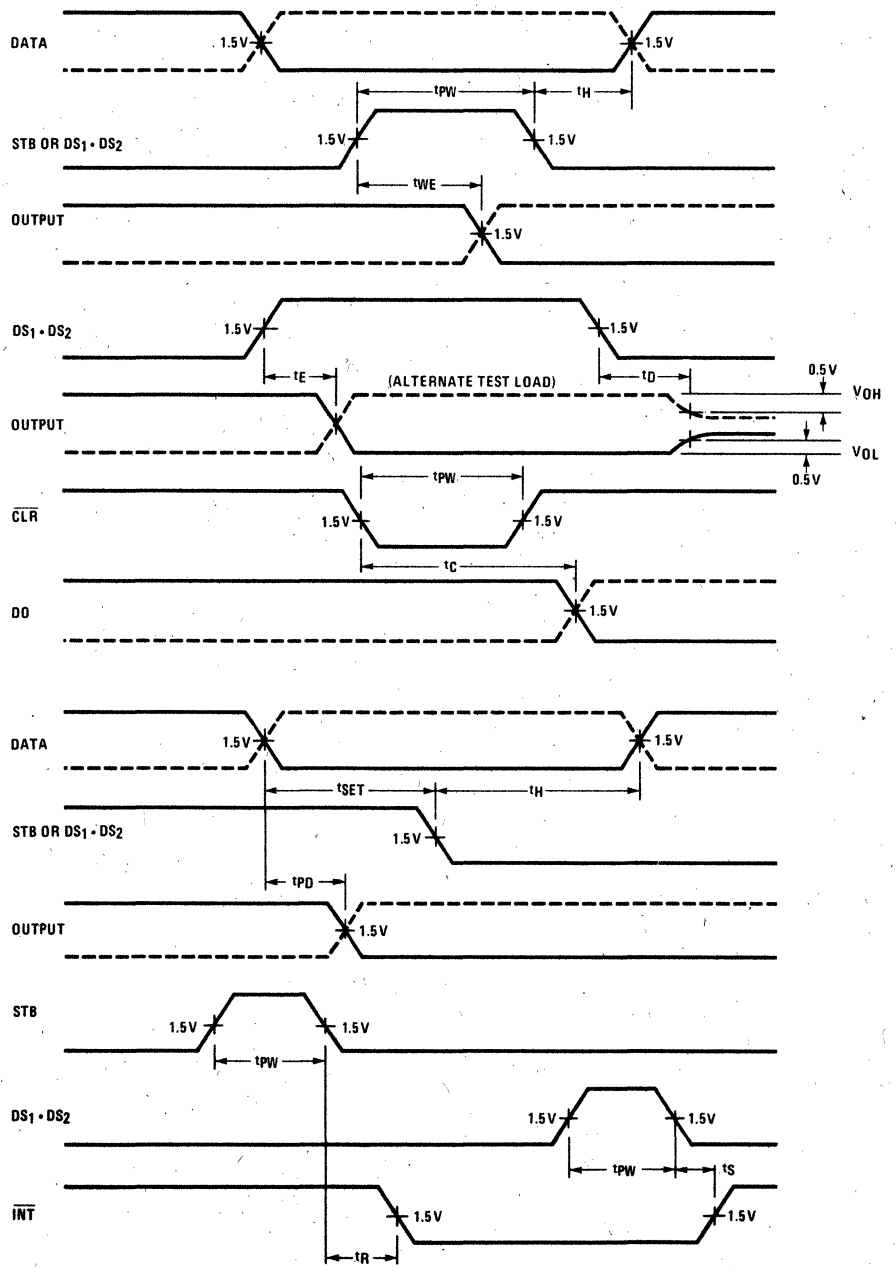

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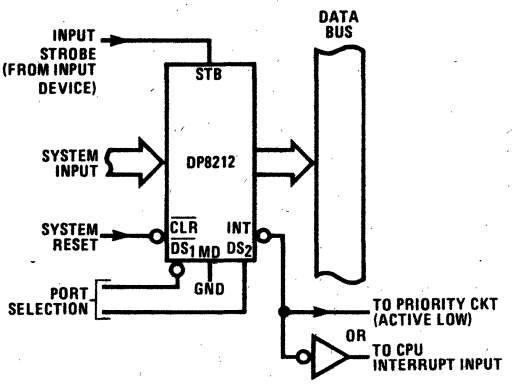
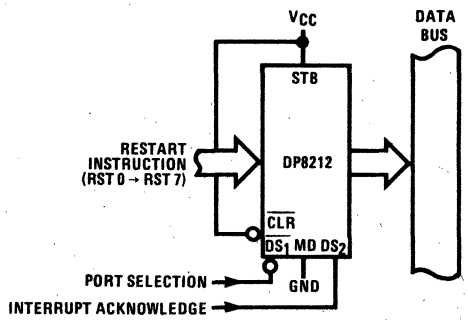
applications in microcomputer systems (cont')

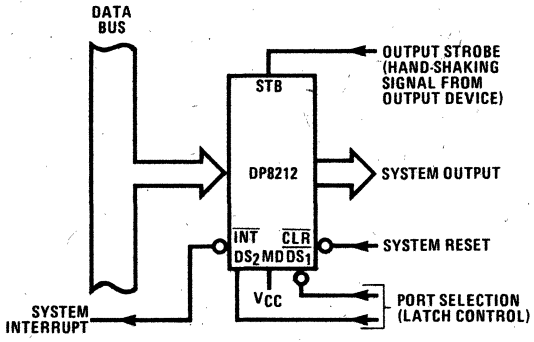
Interrupting Input Port



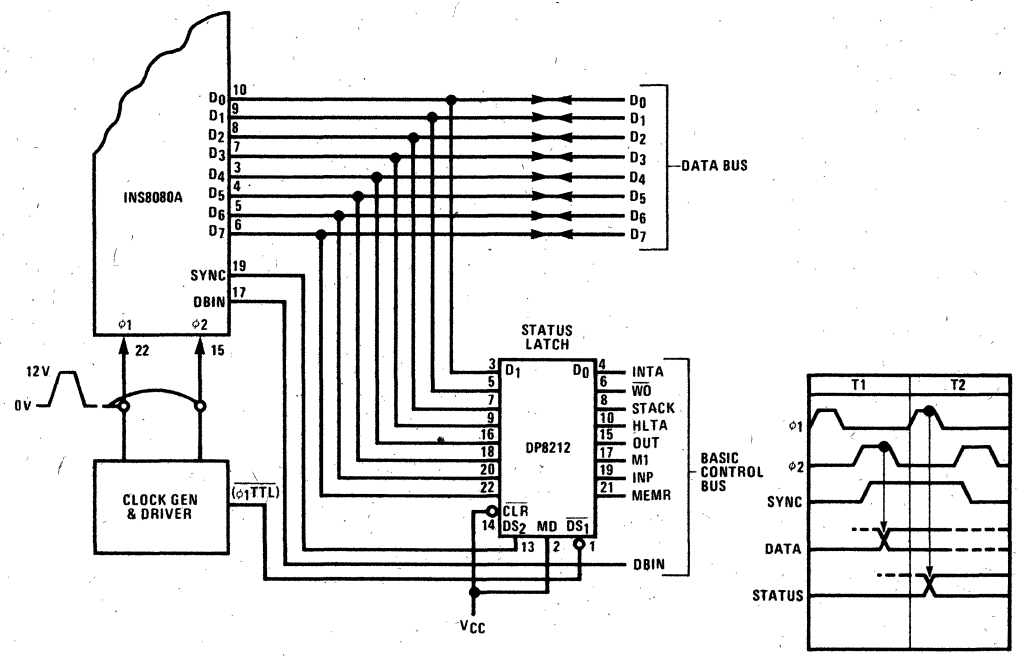
Interrupt Instruction Port



Output Port (with Hand-Shaking)



INS8080A Status Latch



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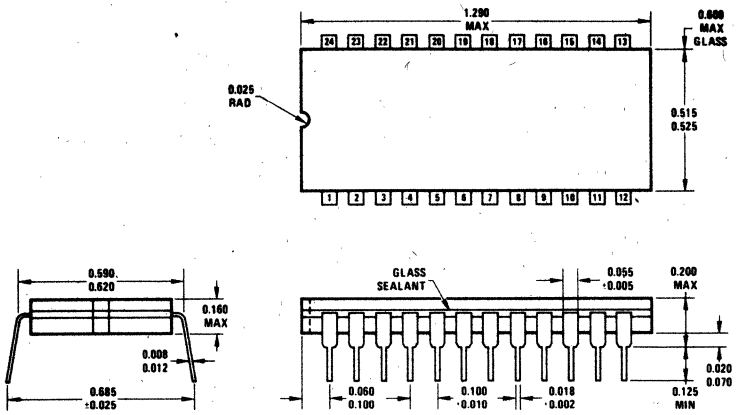
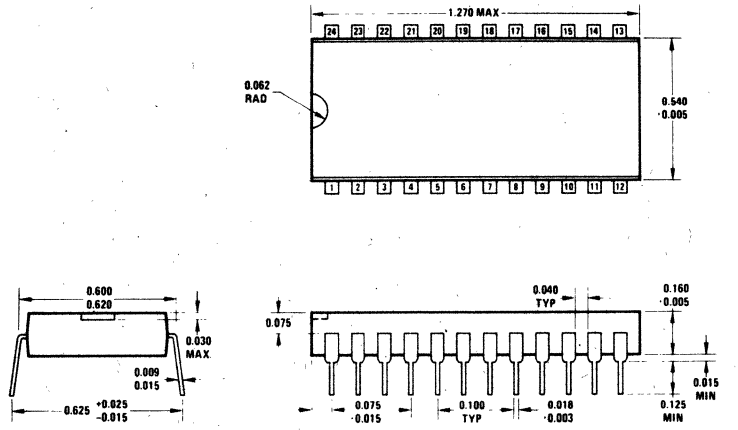
physical dimensions



Ceramic Dual-in-Line Package (J)
Order Number DP8212J



Epoxy Dual-in-Line Package (N)
Order Number DP8212N

Manufactured under one or more of the following U.S. patents: 3083262, 3189758, 3231797, 3303356, 3317671, 3323071, 3381071, 3408542, 3421025, 3426423, 3440498, 3518750, 3519897, 3557431, 3560765, 3566218, 3571630, 3575609, 3579059, 3593069, 3597643, 3607469, 3617859, 3631312, 3633052, 3638131, 3648071, 3651565, 3693248.

National Semiconductor Corporation
2900 Semiconductor Drive, Santa Clara, California 95051, (408) 737-5000/TWX (910) 339-9240
National Semiconductor GmbH
808 Fuerstenfeldbruck, Industriestrasse 10, West Germany, Tele. (08141) 1371/Telex 05-27649
National Semiconductor (UK) Ltd.
Larkfield Industrial Estate, Greenock, Scotland, Tele. (0475) 33251/Telex 778-632

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National Semiconductor

DP8224 Clock Generator and Driver

general description

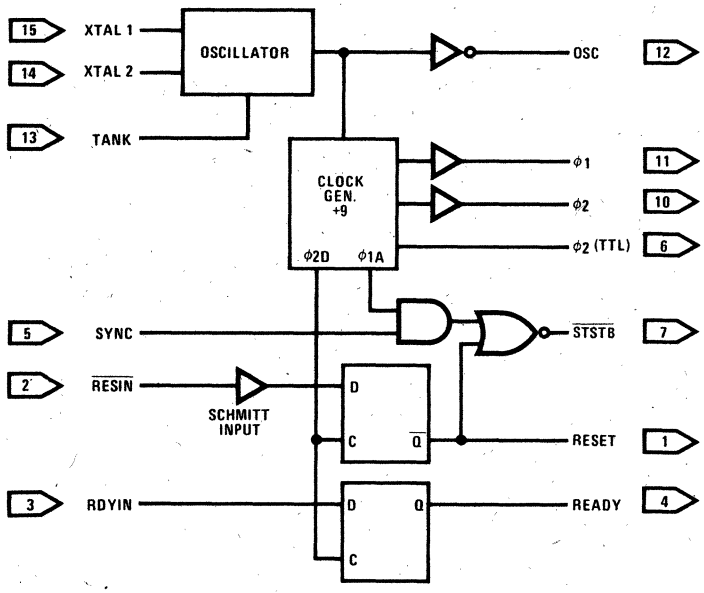
The DP8224 is a clock generator/driver contained in a standard, 16-pin dual-in-line package. The chip, which is fabricated using Schottky Bipolar technology, generates clocks and timing for National Semiconductor's N8080 microcomputer family.

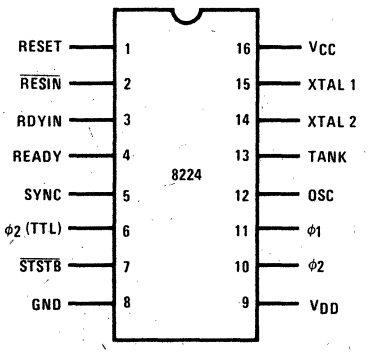
Included in the DP8224 is an oscillator circuit that is controlled by an external crystal, which is selected by the designer to meet a variety of system speed requirements. Also included in the chip are circuits that provide: a status strobe for the DP8228 or DP8238 system controllers, power-on reset for the INS8080A microprocessor, and synchronization of the READY input to the INS8080A.

features

- Crystal-Controlled Oscillator for Stable System Operation
- Single Chip Clock Generator and Driver for INS8080A Microprocessor
- Provides Status Strobe for DP8228 or DP8238 System Controllers
- Provides Power-On Reset for INS8080A Microprocessor
- Synchronizes READY Input to INS8080A Microprocessor
- Provides Oscillator Output for Synchronization of External Circuits
- Reduces System Component Count

logic diagram and pin configuration





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absolute maximum ratings (NOTE 2)

Supply Voltage, V_{CC} . . . . . 7 V
V_{DD} . . . . . 15 V
Input Voltage . . . . . −1.0 V to +5.5 V
Storage Temperature Range . . . . . −65°C to +150°C
Lead Temperature (Soldering, 10 seconds) . . . . . 300°C

operating conditions

	Min.	Max.	Units
Supply Voltage			
V_{CC}	4.75	5.25	V
V_{DD}	11.4	12.6	V
Temperature	0	70	°C

dc electrical characteristics

T_A = 0°C to +70°C; V_{CC} = +5.0 V ± 5%; V_{DD} = +12 V ± 5%.

Symbol	Parameter	Limits			Units	Test Conditions
		Min.	Typ.	Max.		
I_F	Input Current Loading			−0.25	mA	V_F = 0.45 V
I_R	Input Leakage Current			10	μA	V_R = 5.25 V
V_C	Input Forward Clamp Voltage			1.0	V	I_C = −5 mA
V_{IL}	Input "Low" Voltage			0.8	V	V_{CC} = 5.0 V
V_{IH}	Input "High" Voltage	2.6 2.0			V V	$\overline{RESIN}$ Input All Other Inputs
V_{IH} - V_{IL}	$\overline{RESIN}$ Input Hysteresis	0.25			V	V_{CC} = 5.0 V
V_{OL}	Output "Low" Voltage			0.45 0.45	V V	(ϕ_1, ϕ_2), Ready, Reset, $\overline{STSTB}$ I_{OL} = 2.5 mA All Other Outputs I_{OL} = 15 mA
V_{OH}	Output "High" Voltage ϕ_1, ϕ_2 READY, RESET All Other Outputs	 9.4 3.6 2.4			 V V V	 I_{OH} = −100 μA I_{OH} = −100 μA I_{OH} = −1 mA
I_{SC}[1]	Output Short Circuit Current (All Low Voltage Outputs Only)	−10		−60	mA	V_O = 0 V V_{CC} = 5.0 V
I_{CC}	Power Supply Current			115	mA	
I_{DD}	Power Supply Current			12	mA	

Notes:
1. Caution — ϕ_1 and ϕ_2 output drivers do not have short circuit protection.
2. "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

crystal requirements

Tolerance . . . . . 0.005% at 0°C to +70°C
Resonance . . . . . Series (Fundamental)*
Load Capacitance . . . . . 20 pF to 30 pF
Equivalent Resistance . . . . . 75 Ω to 20 Ω
Power Dissipation (min) . . . . . 4 mW

*With tank circuit use 3rd overtone mode.

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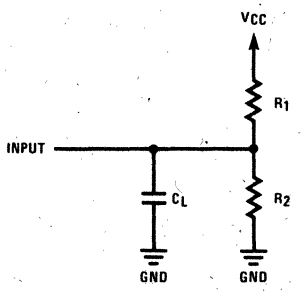
ac electrical charicteristics

$T_A = 0°C$ to $+70°C$; $V_{CC} = +5.0\ V \pm 5\%$; $V_{DD} = +12\ V \pm 5\%$.

Symbol	Parameter	Limits			Units	Test Conditions
		Min.	Typ.	Max.		
$t_{\phi 1}$	ϕ_1 Pulse Width	$\frac{2t_{CY}}{9} - 20\ ns$			ns	$C_L = 20\ pF$ to $50\ pF$
$t_{\phi 2}$	ϕ_2 Pulse Width	$\frac{5t_{CY}}{9} - 35\ ns$				
t_{D1}	ϕ_1 to ϕ_2 Delay	0				
t_{D2}	ϕ_2 to ϕ_1 Delay	$\frac{2t_{CY}}{9} - 14\ ns$				
t_{D3}	ϕ_1 to ϕ_2 Delay	$\frac{2t_{CY}}{9}$		$\frac{2t_{CY}}{9} + 20\ ns$		
t_R	ϕ_1 and ϕ_2 Rise Time			20		
t_F	ϕ_1 and ϕ_2 Fall Time			20		
$t_{D\phi 2}$	ϕ_2 to ϕ_2 (TTL) Delay	−5		+15	ns	ϕ_2 TTL, $C_L = 30\ pF$ $R_1 = 300\ \Omega$ $R_2 = 600\ \Omega$
t_{DSS}	ϕ_2 to $\overline{STSTB}$ Delay	$\frac{6t_{CY}}{9} - 30\ ns$		$\frac{6t_{CY}}{9}$		$\overline{STSTB}$, $C_L = 15\ pF$ $R_1 = 2\ k\Omega$ $R_2 = 4\ k\Omega$
t_{PW}	$\overline{STSTB}$ Pulse Width	$\frac{t_{CY}}{9} - 15\ ns$				
t_{DRS}	RDYIN Setup Time to Status Strobe	$50\ ns - \frac{4t_{CY}}{9}$				
t_{DRH}	RDYIN Hold Time After $\overline{STSTB}$	$\frac{4t_{CY}}{9}$				
t_{DR}	READY or RESET to ϕ_2 Delay	$\frac{4t_{CY}}{9} - 25\ ns$				Ready & Reset $C_L = 10\ pF$ $R_1 = 2\ k\Omega$ $R_2 = 4\ k\Omega$
t_{CLK}	CLK Period		$\frac{t_{CY}}{9}$			
f_{MAX}	Maximum Oscillating Frequency	27			MHz	
C_{IN}	Input Capacitance			8	pF	$V_{CC} = +5.0\ V$ $V_{DD} = +12\ V$ $V_{BIAS} = 2.5\ V$ $f = 1\ MHz$

test circuit



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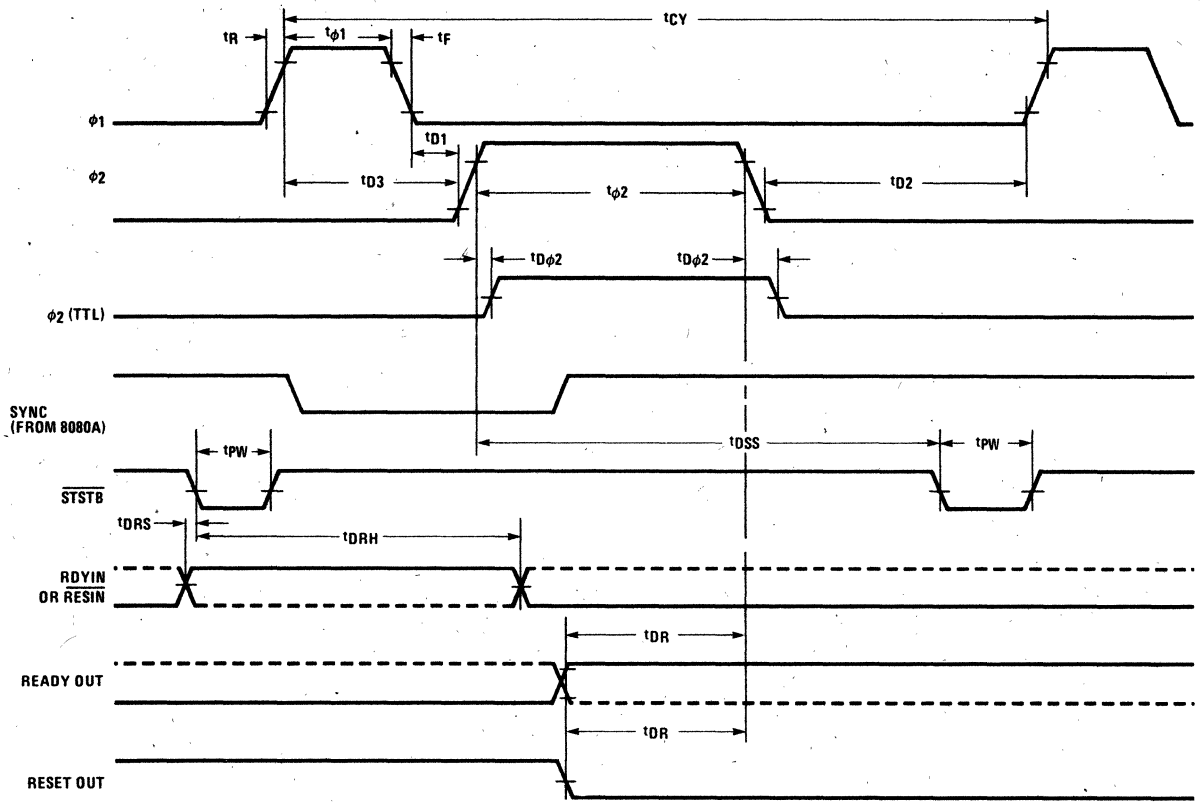
waveforms



VOLTAGE MEASUREMENT POINTS: ϕ_1, ϕ_2 Logic "0" = 1.0 V, Logic "1" = 8.0 V. All other signals measured at 1.5 V.

ac electrical charicteristics (For t_{CY} = 488.28 ns)

T_A = 0°C to +70°C; V_{CC} = +5.0 V ± 5%; V_{DD} = +12 V ± 5%.

Symbol	Parameter	Limits			Units	Test Conditions
		Min.	Typ.	Max.		
$t_{\phi1}$	ϕ_1 Pulse Width	89			ns	t_{CY} = 488.28 ns
$t_{\phi2}$	ϕ_2 Pulse Width	236			ns	
t_{D1}	Delay ϕ_1 to ϕ_2	0			ns	
t_{D2}	Delay ϕ_2 to ϕ_1	95			ns	ϕ_1 & ϕ_2 Loaded to C_L = 20 to 50 pF
t_{D3}	Delay ϕ_1 to ϕ_2 Leading Edges	109		129	ns	
t_r	Output Rise Time			20	ns	
t_f	Output Fall Time			20	ns	
t_{DSS}	ϕ_2 to $\overline{STSTB}$ Delay	296		326	ns	
$t_{D\phi2}$	ϕ_2 to ϕ_2 (TTL) Delay	-5		+15	ns	
t_{PW}	Status Strobe Pulse Width	40			ns	
t_{DRS}	RDYIN Setup Time to $\overline{STSTB}$	-167			ns	Ready & Reset Loaded to 2 mA/10 pF
t_{DRH}	RDYIN Hold Time after $\overline{STSTB}$	217			ns	All measurements referenced to 1.5 V unless specified otherwise.
t_{DR}	READY or RESET to ϕ_2 Delay	192			ns	
f_{MAX}	Oscillator Frequency			18.432	MHz	

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DP8224 functional pin definitions

The following describes the function of all of the DP8224 input/output pins. Some of these descriptions reference internal circuits.

INPUT SIGNALS

Crystal Connections (XTAL 1 and XTAL 2): Two inputs that connect an external, series resonant, crystal to the oscillator circuit of the DP8224. Normally, a fundamental mode crystal is used to determine the basic operating frequency of the oscillator. However, overtone mode crystals may also be used. The crystal frequency is nine times the desired microprocessor speed (that is, crystal frequency = $1/t_{CY} \times 9$). When the crystal frequency is above 10 MHz, a selected capacitor (3 to 10 picofarads) may have to be connected in series with the crystal to produce the exact desired frequency.

Tank: Allows the use of overtone mode crystals with the oscillator circuit. When an overtone mode crystal is used, the tank input connects to a parallel LC network that is ac coupled to ground. The formula for determining the resonant frequency of this LC network is as follows:

$$F = \frac{1}{2\pi\sqrt{LC.}}$$

Synchronizing (SYNC) Signal: When high, indicates the beginning of a new machine cycle. The INS8080A microprocessor outputs a status word (which describes the current machine cycle) onto its data bus during the first state (SYNC interval) of each machine cycle.

Reset In ($\overline{\text{RESIN}}$): Provides an automatic system reset and start-up upon application of power as follows. The $\overline{\text{RESIN}}$ input, which is obtained from the junction of an external RC network that is connected between V_{CC} and ground, is routed to an internal Schmitt Trigger circuit. This circuit converts the slow transition of the power supply rise into a sharp, clean edge when its input reaches a predetermined value. When this occurs, an internal D-type flip-flop is synchronously reset, thereby providing the RESET output signal discussed below.

For manual system reset, a momentary contact switch that provides a low (ground) when closed is also connected to the $\overline{\text{RESIN}}$ input.

Ready In (RDYIN): An asynchronous READY signal that is re-clocked by a D-type flip-flop of the DP8224 to provide the synchronous READY output discussed below.

+5 Volts: V_{CC} supply.

+12 Volts: V_{DD} supply.

Ground: 0 volt reference.

OUTPUT SIGNALS

Oscillator (OSC): A buffered oscillator signal that can be used for external timing purposes.

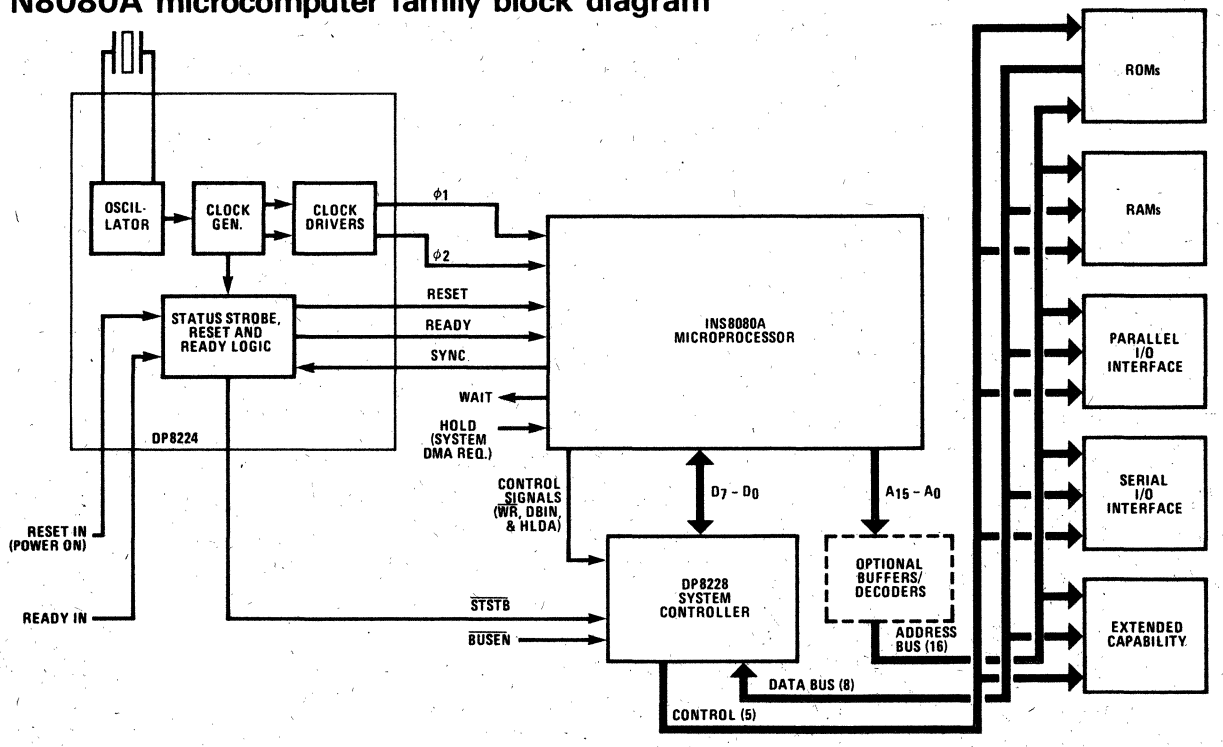
ϕ_1 and ϕ_2 Clocks: Two non-TTL compatible clock phases that provide nonoverlapping timing references for internal storage elements and logic circuits of the INS8080A microprocessor. The two clock phases are produced by an internal clock generator that consists of a divide-by-nine counter and the associated decode gating logic.

ϕ_2 (TTL) Clock: A TTL ϕ_2 clock phase that can be used for external timing purposes.

Status Strobe ($\overline{\text{STSTB}}$): Activated (low) at the start of each new machine cycle. The $\overline{\text{STSTB}}$ signal is generated by gating a high-level SYNC input with the ϕ_{1A} timing signal from the internal clock generator of the DP8224. The $\overline{\text{STSTB}}$ signal is used to clock status information into the status latch of the DP8228 system controller and bus driver.

The power-on reset $\overline{\text{RESIN}}$ input also generates a $\overline{\text{STSTB}}$ signal. However, since this signal lasts for a longer duration, it is used to reset the status latch of the DP8228.

N8080A microcomputer family block diagram



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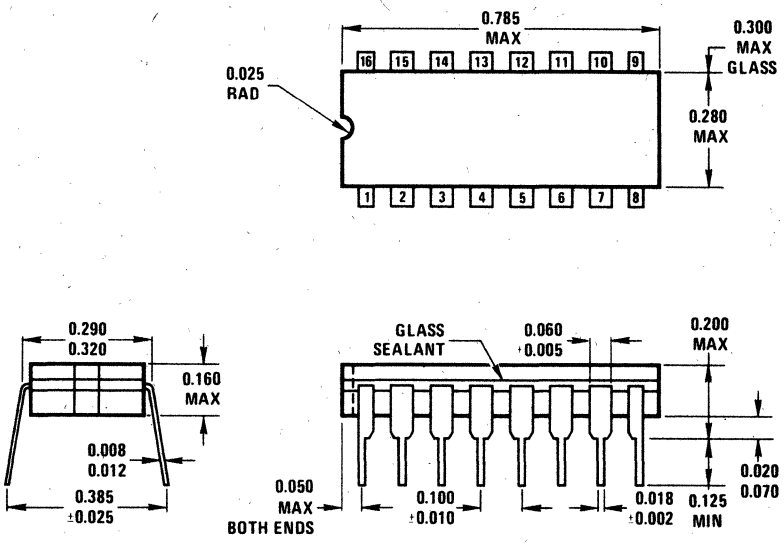
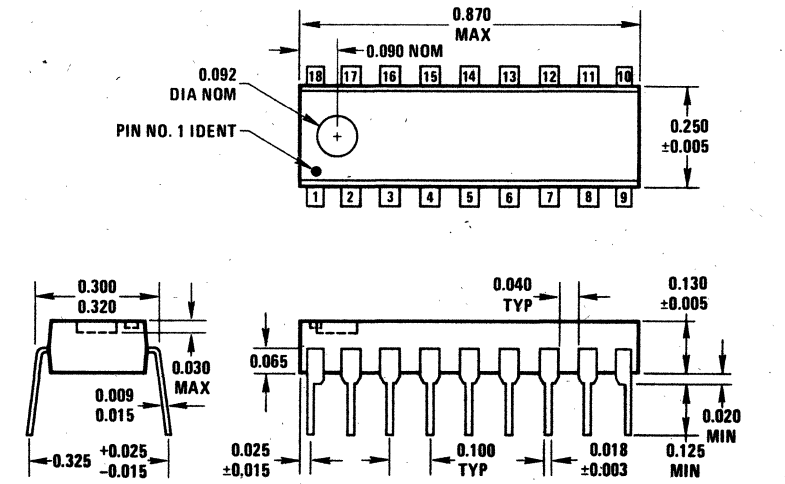
physical dimensions



Order Number 8224(J)



Order Number 8224(N)

Manufactured under one or more of the following U.S. patents: 3083262, 3189758, 3231797, 3303356, 3317671, 3323071, 3381071, 3408542, 3421025, 3426423, 3440498, 3518750, 3519897, 3557431, 3560765, 3566218, 3571630, 3575609, 3579059, 3593069, 3597640, 3607469, 3617859, 3631312, 3633052, 3638131, 3648071, 3651565, 3693248.

National Semiconductor Corporation
2900 Semiconductor Drive, Santa Clara, California 95051, (408) 737-5000/TWX (910) 339-9240
National Semiconductor GmbH
808 Fuerstenfeldbruck, Industriestrasse 10, West Germany, Tele. (08141) 1371/Telex 05-27649
National Semiconductor (UK) Ltd.
Larkfield Industrial Estate, Greenock, Scotland, Tele. (0475) 33251/Telex 778-632

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DP8228/DP8238 system controller and bus driver

general description

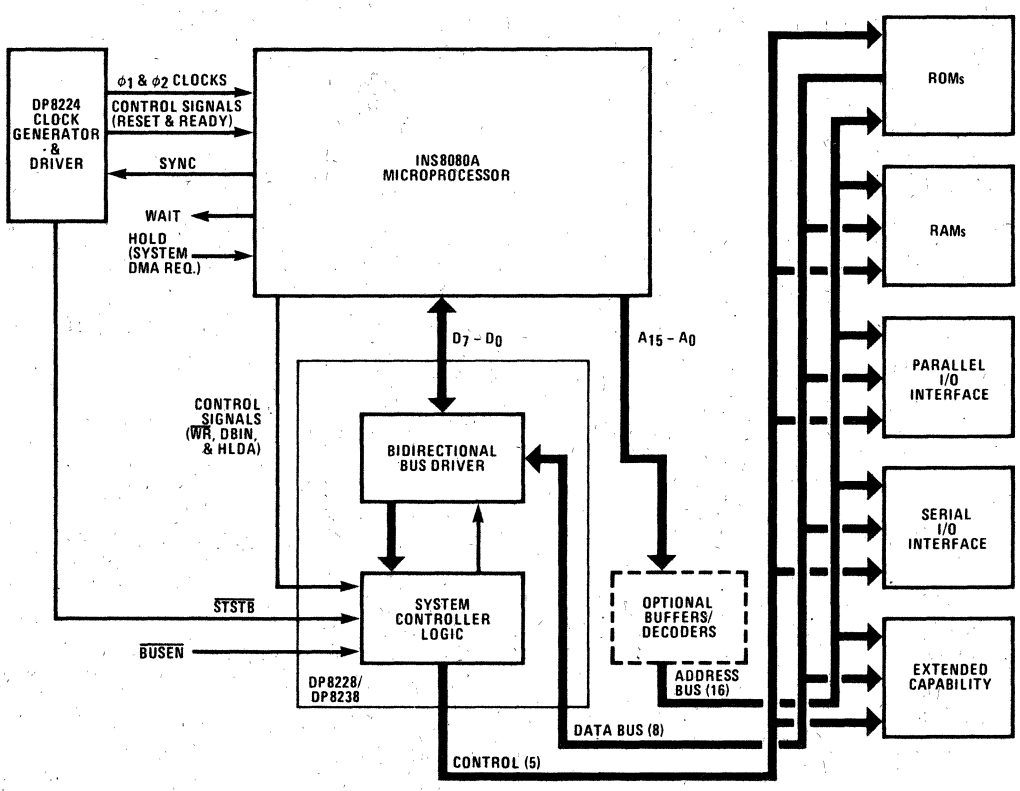
The DP8228/DP8238 is a system controller/bus driver contained in a standard, 28-pin dual-in-line package. The chip, which is fabricated using Schottky Bipolar technology, generates all the read and write control signals required to directly interface the memory and input/output components of National Semiconductor's INS8080A microcomputer family. The chip also provides drive and isolation for the bidirectional data bus of the INS8080A microprocessor. Data bus isolation enables the use of slower memory and input/output components in a system, and provides for enhanced system noise immunity.

A user-selected single-level interrupt vector (RST 7) is provided by the chip for use in the interrupt structure of small systems that need only one basic vector. No additional components (such as an interrupt instruction port) are required to use the single interrupt vector in these systems. The DP8228/DP8238 also generates an Interrupt Acknowledge ($\overline{INTA}$) control signal for each byte of a multibyte CALL instruction when an interrupt is acknowledged by the INS8080A. This feature permits the use of a multilevel priority interrupt structure in large, interrupt-driven systems.

features

- Single Chip System Controller and Bus Driver for INS8080A Microcomputer Systems
- Allows Use of Multibyte CALL Instructions for Interrupt Acknowledge
- Provides User-Selected Single-Level Interrupt Vector (RST 7)
- Provides Isolation for Data Bus
- Supports A Wide Variety of System Bus Structures
- Reduces System Component Count
- DP8238 Provides Advanced Input/Output Write and Memory Write Control Signals for Large System Timing Control

N8080A microcomputer family block diagram



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absolute maximum ratings

Temperature Under Bias . . . . . 0°C to +70°C
Storage Temperature . . . . . −65°C to +150°C
Supply Voltage, V_{CC} . . . . . −0.5 V to +7 V
Input Voltage . . . . . −1.5 V to +7 V
Output Current . . . . . 100 mA

dc electrical characteristics

T_A = 0°C to +70°C; V_{CC} = 5 V ± 5%.

Symbol	Parameter	Limits			Units	Test Conditions
		Min.	Typ.[1]	Max.		
V_C	Input Clamp Voltage, All Inputs		0.75	−1.0	V	V_{CC} = 4.75 V; I_C = −5 mA
I_F	Input Load Current					
	$\overline{STSTB}$			500	μA	V_{CC} = 5.25 V
	D_2 & D_6			750	μA	V_F = 0.45 V
	D_0, D_1, D_4, D_5, & D_7			250	μA	
	All Other Inputs			250	μA	
I_R	Input Leakage Current					
	$\overline{STSTB}$			100	μA	V_{CC} = 5.25 V
	DB_0 - DB_7			20	μA	V_R = 5.25 V
	All Other Inputs			100	μA	
V_{TH}	Input Threshold Voltage, All Inputs	0.8		2.0	V	V_{CC} = 5 V
I_{CC}	Power Supply Current		140	190	mA	V_{CC} = 5.25 V
V_{OL}	Output Low Voltage					
	D_0 - D_7			0.45	V	V_{CC} = 4.75 V; I_{OL} = 2 mA
	All Other Outputs			0.45	V	I_{OL} = 10 mA
V_{OH}	Output High Voltage					
	D_0 - D_7	3.6	3.8		V	V_{CC} = 4.75 V; I_{OH} = −10 μA
	All Other Outputs	2.4			V	I_{OH} = −1 mA
I_{OS}	Short Circuit Current, All Outputs	15		90	mA	V_{CC} = 5 V
$I_{O\,(off)}$	Off State Output Current			100	μA	V_{CC} = 5.25 V; V_O = 5.25 V
	All Control Outputs			−100	μA	V_O = 0.45 V
I_{INT}	INTA Current			5	mA	(See Test Conditions—Pg. 3)

Notes:
1. Typical values are for T_A = 25°C and nominal supply voltages.

capacitance

This parameter is periodically sampled and not 100% tested.

Symbol	Parameter	Limits			Units
		Min.	Typ.[1]	Max.	
C_{IN}	Input Capacitance		8	12	pF
C_{OUT}	Output Capacitance Control Signals		7	15	pF
I/O	I/O Capacitance (D or DB)		8	15	pF

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ac electrical characteristics

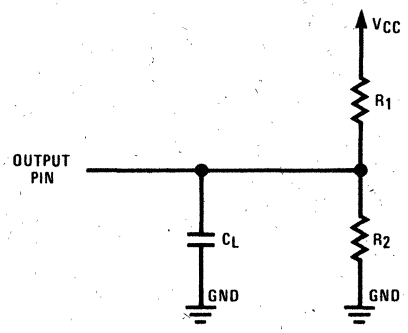
$T_A = 0°C$ to $+70°C$; $V_{CC} = 5\ V \pm 5\%$.

Symbol	Parameter	Limits		Units	Condition
		Min.	Max.		
t_{PW}	Width of Status Strobe	22		ns	
t_{SS}	Setup Time, Status Inputs D_0 - D_7	8		ns	
t_{SH}	Hold Time, Status Inputs D_0 - D_7	5		ns	
t_{DC}	Delay from $\overline{STSTB}$ to any Control Signal	20	60	ns	$C_L = 100$ pF
t_{RR}	Delay from DBIN to Control Outputs		30	ns	$C_L = 100$ pF
t_{RE}	Delay from DBIN to Enable/Disable 8080 Bus		45	ns	$C_L = 25$ pF
t_{RD}	Delay from System Bus to 8080 Bus during Read		30	ns	$C_L = 25$ pF
t_{WR}	Delay from $\overline{WR}$ to Control Outputs	5	45	ns	$C_L = 100$ pF
t_{WE}	Delay to Enable System Bus DB_0 - DB_7 after $\overline{STSTB}$		30	ns	$C_L = 100$ pF
t_{WD}	Delay from 8080 Bus D_0 - D_7 to System Bus DB_0 - DB_7 during Write	5	40	ns	$C_L = 100$ pF
t_E	Delay from System Bus Enable to System Bus DB_0 - DB_7		30	ns	$C_L = 100$ pF
t_{HD}	HLDA to Read Status Outputs		25	ns	$C_L = 100$ pF
t_{DS}	Setup Time, System Bus Inputs to HLDA	10		ns	
t_{DH}	Hold Time, System Bus Inputs to HLDA	20		ns	

test conditions

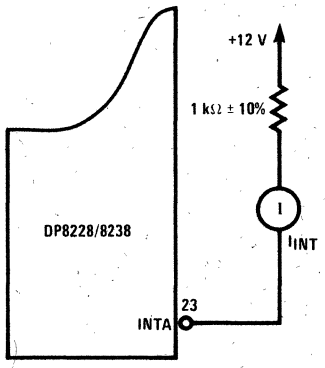
$V_{BIAS} = 2.5\ V$, $V_{CC} = 5.0\ V$, $T_A = 25°C$, f = 1 MHz.

Test Load[2]



2. For D_0 - D_7: $R_1 = 4\ k\Omega$, $R_2 = \infty$, $C_L = 25$ pF. For all other outputs: $R_1 = 500\ \Omega$, $R_2 = 1\ k\Omega$, $C_L = 100$ pF.

INTA Test Circuit (for RST 7)



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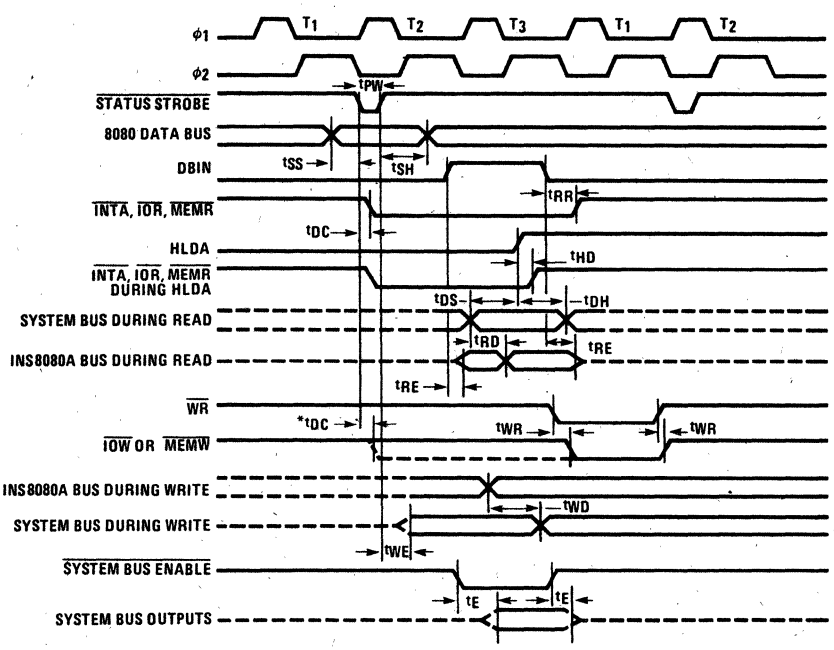
waveforms



VOLTAGE MEASUREMENT POINTS: D_0 - D_7 (when outputs) Logic "0" = 0.8 V, Logic "1" = 3.0 V. All other signals measured at 1.5 V.

*Advanced I/OW MEMW for 8238 only.

DP8228/DP8238 functional pin definitions

The following describes the function of all of the DP8228/DP8238 pinouts. Some of these descriptions reference internal circuits.

INPUT SIGNALS

Status Strobe ($\overline{STSTB}$): Activated (low) at the start of each new machine cycle. The $\overline{STSTB}$ input is used to store a status word (refer to chart) from the INS8080A microprocessor into the internal status latch of the DP8228/DP8238. The INS8080A outputs this status word onto its data bus during the first state (SYNC interval) of each machine cycle.

Data Bus In (DBIN): When high, indicates that the INS8080A data bus is in the input mode. The DBIN signal is used to gate data from memory or an input/output device onto the data bus.

Write ($\overline{WR}$): When low, indicates that the data on the INS8080A data bus are stable for WRITE memory or output operation.

Hold Acknowledge (HLDA): When high, indicates that the INS8080A data and address buses will go to their high impedance state. When in the data bus read mode, DBIN input in the high state, a high HLDA input will latch the data bus information into the driver circuits and gate off the applicable control signal $\overline{I/OR}$, $\overline{MEMR}$, or $\overline{INTA}$ (return to the output high state).

Bus Enable ($\overline{BUSEN}$): Asynchronous DMA input to the internal gating array of the DP8228/DP8238. When low, normal operation of the internal bidirectional bus driver and gating array occurs. When high, the bus driver and gating array are driven to their high impedance state.

V_{CC} Supply: +5 volts.

Ground: 0 volt reference.

OUTPUT SIGNALS

Memory Read ($\overline{MEMR}$): When low, signals data to be loaded in from memory. The $\overline{MEMR}$ signal is generated by strobing in status word 1, 2, or 4. (Refer to status word chart.)

Memory Write ($\overline{MEMW}$): When low, signals data to be stored in memory. The $\overline{MEMW}$ signal is generated for the DP8238 by strobing in status word 3 or 5. (Refer to status word chart.) For the DP8228, the $\overline{MEMW}$ signal is generated by gating a low-level $\overline{WR}$ input with the strobed in status word 3 or 5.

Input/Output Read ($\overline{I/OR}$): When low, signals data to be loaded in from an addressed input/output device. The $\overline{I/OR}$ signal is generated by strobing in status word 6.

Input/Output Write ($\overline{I/OW}$): When low, signals data to be transferred to an addressed input/output device. The I/OW signal for the DP8238 is generated by strobing in status word 7. For the DP8228 the $\overline{I/OW}$ signal is generated by gating in a low-level WR input with the strobed in status word 7.

Interrupt Acknowledge ($\overline{INTA}$): When low, indicates that an interrupt has been acknowledged by the INS8080A microprocessor. The $\overline{INTA}$ signal is generated by strobing in status word 8 or 10.

Single Level Interrupt (RST 7): When the $\overline{INTA}$ output is tied to 12 V through a 1 kΩ resistor, strobing in status work 8 or 10 will cause the CPU data bus outputs, when active, to go to the high state.

INPUT/OUTPUT SIGNALS

CPU Data (D_7 - D_0) Bus: This bus comprises eight TRI-STATE input/output lines that connect to the INS8080A microprocessor. The bus provides bidirec-

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DP8228/DP8238 functional pin definitions (con'd.)

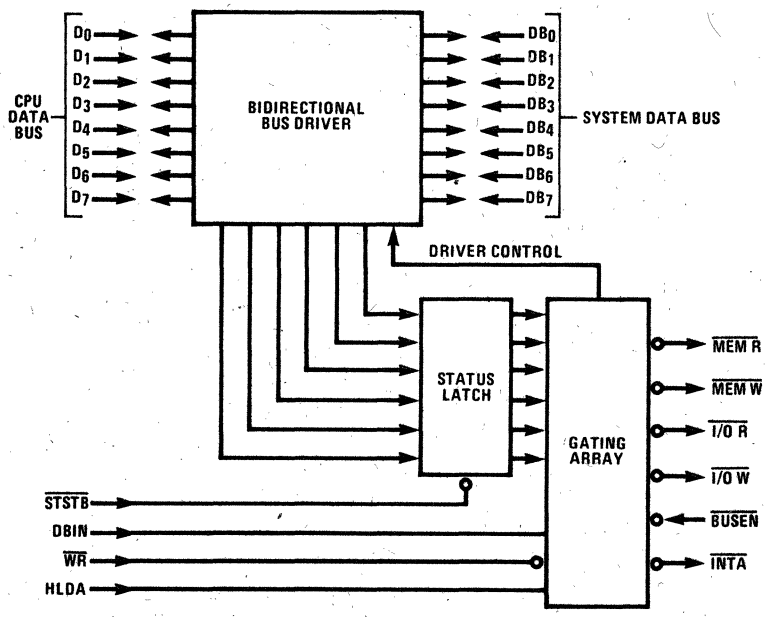
tional communication between the CPU, memory, and input/output devices for instructions and data transfers. A status word (which describes the current machine cycle) is also outputted on this data bus during the first microcycle of each machine cycle (SYNC = logic 1).

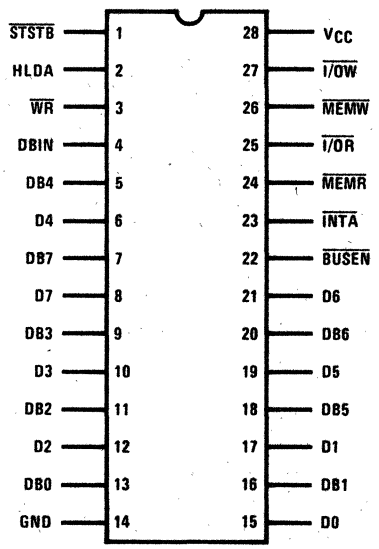
System Data (DB_7 - DB_0) Bus: This bus comprises eight TRI-STATE input/output lines that connect to the memory and input/output components of the system. The internal bidirectional bus driver isolates the DB_7 - DB_0 Data Bus from the D_7 - D_0 Data Bus.

Status Word Chart

Machine Cycle	Status Word	Data Bus Bit								Control Signal
		D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	
Instruction Fetch	1	1	0	1	0	0	0	1	0	$\overline{MEMR}$
Memory Read	2	1	0	0	0	0	0	1	0	$\overline{MEMR}$
Memory Write	3	0	0	0	0	0	0	0	0	$\overline{MEMW}$
Stack Read	4	1	0	0	0	0	1	1	0	$\overline{MEMR}$
Stack Write	5	0	0	0	0	0	1	0	0	$\overline{MEMW}$
Input Read	6	0	1	0	0	0	0	1	0	$\overline{I/OR}$
Output Write	7	0	0	0	1	0	0	0	0	$\overline{I/OW}$
Interrupt Acknowledge	8	0	0	1	0	0	0	1	1	$\overline{INTA}$
Halt Acknowledge	9	1	0	0	0	1	0	1	0	(none)
Interrupt Acknowledge While Halt	10	0	0	1	0	1	0	1	1	$\overline{INTA}$

DP8228/DP8238 block diagram and pin configuration





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DP8300 PACE bidirectional transceiver element (PACE BTE/8)

general description

The DP8300 is an 8-bit TRI-STATE® MOS/TTL bus transceiver element specifically intended for application in PACE microprocessor-based systems. Its electrical characteristics and control flexibility make the BTE/8 attractive in other applications requiring the translation of MOS current outputs to high fan-out TTL levels.

Two BTE/8 devices provide complete system buffering for all 16-bit address and data input/output between the PACE CPU and all system memory and peripheral interfaces.

In the driving mode, the MOS sense amplifiers convert the MOS current outputs of the PACE CPU to a fan-out 30 (50 mA) TTL system bus. [This characteristic makes the BTE/8 an ideal buffer (driving mode only) for the PACE system timing and control bus consisting of the address data strobe (NADS), input data strobe (IDS), output data strobe (ODS) and the four output control flags (F11, F12, F13, F14).]

In the receiving mode the BTE accepts bus data through high impedance input buffers and applies the TTL signals to the PACE I/O pins.

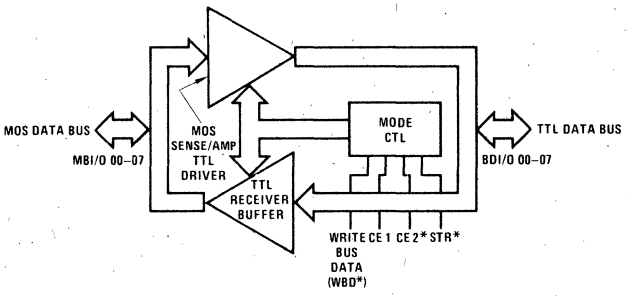
A third mode allows both the MOS and TTL bus to be placed in the TRI-STATE (high impedance) mode. This function facilitates direct memory access (DMA) over the TTL system bus.

A latched chip enable allows the use of multiplexed address/data lines to drive CE 1 and CE 2*, selecting the BTE/8 for an input cycle. The latching function may be eliminated by connecting the strobe to ground.

features

- High TTL fan-out eliminates additional buffering requirements
- Low system data bus loading for minimum input drive
- TRI-STATE data ports and chip enables maximize application flexibility
- 8-bit parallel data flow reduces system package count
- Pin-outs are compatible with hybrid version and simplify system interconnections and layout
- Latched chip enable simplifies transmit/receive control
- High voltage output high level (V_{CC} – 1.1V) on TTL bus

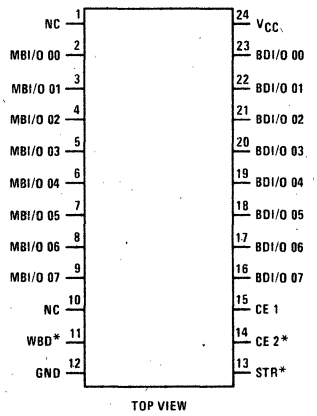
block diagram



Signal* = N Signal = $\overline{\text{Signal}}$ = Low Active Signal

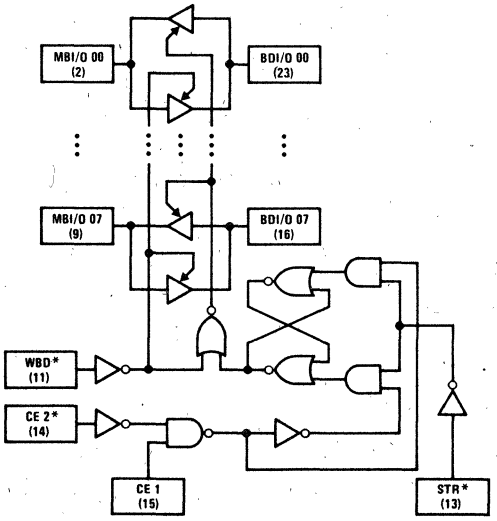
connection diagram

Dual-In-Line Package



TOP VIEW

logic diagram



truth table

t_n			$t_n + 1$	
CE 1	CE 2*	STR*	WBD*	TRANSCEIVER MODE
X	X	X	0	Receiving MOS Bus and Driving TTL Bus
X	X	1	1	Mode t_n. See Note 1
0	0	0	1	TRI-STATE Mode
0	1	0	1	TRI-STATE Mode
1	0	0	1	Receiving TTL Bus and Driving MOS Bus
1	1	0	1	TRI-STATE Mode

Note 1. On the positive-edge transition of STR* logic conditions present on CE 1 and CE 2* at the time of transition will be latched internally. The transceiver will either be in the TRI-STATE or receiving mode.

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absolute maximum ratings (Note 1)

Supply Voltage	7V
Input Voltage (All Inputs Except MBI/O Input Active)	5.5V
Output Voltage	5.5V
MOS Bus Input Current	±10 mA
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

recommended operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})	4.75	5.25	V
Temperature (T_A)	0	+70	°C

dc electrical characteristics (Notes 2 and 3)

PARAMETER		CONDITIONS		MIN	TYP	MAX	UNITS
TTL BUS PORT (BDI/O 00–07)							
V_{IH}	Logical "1" Input Voltage			2.0			V
V_{IL}	Logical "0" Input Voltage					0.8	V
V_{OH}	Logical "1" Output Voltage	WBD* = 0.8V, MBI/O = 0.5 mA	I_{OH} = −1 mA	V_{CC}−1.1	V_{CC}−0.8		V
			I_{OH} = −5.2 mA	2.4	3.7		V
V_{OL}	Logical "0" Output Voltage	WBD* = 0.8V, MBI/O = 100μA	I_{OL} = 20 mA		0.25	0.4	V
			I_{OL} = 50 mA		0.4	0.5	V
I_{OS}	Output Short Circuit Current	WBD* = 0.8V, MBI/O = 0.5 mA, V_{OUT} = 0V, V_{CC} = 5.25V, (Note 4)		−10	−35	−75	mA
I_{IH}	Logical "1" Input Current	WBD* = 2V, V_{IH} = 2.4V				80	μA
I_I	Input Current at Maximum Input Voltage	WBD* = 2V, V_{IH} = 5.5V, V_{CC} = 5.25V				1	mA
I_{IL}	Logical "0" Input Current	WBD* = 2V, V_{IL} = 0.4V			−10	−250	μA
V_{CLAMP}	Input Clamp Voltage	WBD* = 2V, I_{IN} = −12 mA			−0.2	−1.5	V
I_{OD}	Output/Input Bus Disable Current	WBD* = STR* = 2V, BDI/O = 0.4V to 4V, V_{CC} = 5.25V		−80		80	μA
MOS BUS PORT (MBI/O 00–07)							
I_O	Logical "0" Input Current	WBD* = 0.8V, $I_{OL(TTL)}$ = 50 mA, $V_{OL} \leq$ 0.5V, (Note 5)		−5.0		0.10	mA
I_1	Logical "1" Input Current	WBD* = 0.8V, $I_{OH(TTL)}$ = −1 mA, $V_{OH} \geq V_{CC}$ − 1.1V, (Notes 5 and 6)		0.50		5.0	mA
V_O	Logical "0" Input Voltage	WBD* = 0.8V, $I_{OL(TTL)}$ = 50 mA, $V_{OL} \leq$ 0.5V				0.8	V
V_1	Logical "1" Input Voltage	WBD* = 0.8V, $I_{OH(TTL)}$ = −1 mA, $V_{OH} \geq V_{CC}$ − 1.1V		2.0	1.5		V
V_{OH}	Logical "1" Output Voltage	WBD* = CE1 = BDI/O = 2V, $I_{OH(MOS)}$ = −1 mA, CE2* = STR* = 0.8V		2.4	3.3		V
V_{OL}	Logical "0" Output Voltage	WBD* = CE1 = 2V, $I_{OL(MOS)}$ = 5 mA, CE2* = STR* = BDI/O = 0.8V			0.28	0.5	V
I_{OS}	Output Short Circuit Current	WBD* = CE1 = BDI/O = 2V, V_{CC} = 5.25V, V_{OUT} = 0V, STR* = CE2* = 0.8V, (Note 4)		−7	−15	−45	mA
V_{CLAMP}	Input Clamp Voltage	I_{IN} = −12 mA				−1.5	V
I_{OD}	Output/Input Bus Disable Current	MBI/O = 0.4V to 4V, V_{CC} = 5.25V		−80		80	μA
CONTROL INPUTS (WBD*, CE1, CE2*, STR*)							
V_{IH}	Logical "1" Input Voltage			2.0			V
V_{IL}	Logical "0" Input Voltage					0.8	V
I_{IH}	Logical "1" Input Current	V_{IN} = 2.4V				20	μA
I_1	Input Current at Maximum Input Voltage	V_{IN} = 5.5V				1.0	mA

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dc electrical characteristics (Continued) (Notes 2 and 3)

PARAMETER		CONDITIONS	MIN	TYP	MAX	UNITS
CONTROL INPUTS (WBD*, CE1, CE2*, STR*) (continued)						
I_{IL}	Logical "0" Input Current	V_{IN} = 0.4V		−250	−400	μA
V_{CLAMP}	Input Clamp Voltage	I_{IN} = −12 mA		−0.85	−1.5	V
POWER SUPPLY CURRENT						
I_{CC}	Power Supply Current	V_{CC} = 5.25V		70	110	mA

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: Unless otherwise specified, min/max limits apply across the 0°C to +70°C temperature range and the 4.75V to 5.25V power supply range. All typicals are given for V_{CC} = 5V and T_A = 25°C.

Note 3: All currents into device pins are shown as positive, out of device pins are negative. All voltages are referenced to ground unless otherwise noted.

Note 4: Only one output at a time should be shorted.

Note 5: The MBI/O Input Characteristic Graph illustrates this parameter and defines the regions of guaranteed logical "0" and logical "1" outputs. See equivalent input structure for clarification. When the MBI/O input is loaded with a high impedance source (open), the TTL output will be in the logic "0" state.

Note 6: The maximum MOS bus positive input current specification is intended to define the upper limit on guaranteed input clamp operation. At higher input currents (up to the absolute maximum rating) clamp operation is not guaranteed but TTL bus logic state is valid and no device damage will occur.

Note 7: In most applications the MOS bus data lines are higher impedance and more sensitive to noise coupling than TTL bus lines. Conservative design practice would dictate routing MOS bus lines away from high speed, low impedance TTL lines and MOS clock lines or providing a ground shield when they are adjacent.

ac electrical characteristics V_{CC} = 5V ±5%, T_A = 0°C to +70°C

PARAMETER		CONDITIONS		MIN	TYP	MAX	UNITS
DATA TRANSFER SPECIFICATIONS							
Receiving Mode (BDI/O Bus to MBI/O Bus)		WBD* = 3V, C_L = 15 pF,	t_{pd0}		17	40	ns
		R_L = 1 kΩ, *(Figures 4 and 6)*	t_{pd1}		20	40	ns
	Driving Mode (MBI/O Bus to BDI/O Bus)	WBD* = CE1 = 0V,	t_{pd0}		40	60	ns
		STR* = CE2* = 3V,	t_{pd1}		40	60	ns
		C_L = 50 pF, R_L = 100 Ω, *(Figures 3 and 5)*					
TRANSCEIVER MODE SPECIFICATIONS							
Select Bus							
t_{DS}	Chip Enable Data Set-Up	*(Figure 1)*		45	23		ns
t_{DH}	Chip Enable Data Hold	*(Figure 1)*		0			ns
t_{ES}	Set-Up	*(Figure 1)*		0			ns
TTL Data Bus (BDI/O 00–07)							
$t_{BD\ OD}$	Bus Data Output Disable	C_L = 5 pF, R_L = 100 Ω, *(Figure 1)*		5	20	50	ns
$t_{BD\ OE}$	Bus Data Output Enable	C_L = 50 pF, R_L = 100 Ω, *(Figure 1)*			25	80	ns
$t_{BD\ IE}$	Bus Data Input Enable	*(Figure 1)*			30		ns
$t_{BD\ ID}$	Bus Data Input Disable	*(Figure 1)*			30		ns
MOS Data Bus (MBI/O 00–07)							
$t_{MB\ OD}$	MOS Bus Output Disable	C_L = 15 pF, R_L = 1 kΩ, *(Figure 1)*		15	50	100	ns
$t_{MB\ OE}$	MOS Bus Output Enable	C_L = 15 pF, R_L = 1 kΩ, *(Figure 1)*			50	100	ns
$t_{MB\ ID}$	MOS Bus Input Disable	*(Figure 1)*			55		ns
$t_{MB\ IE}$	MOS Bus Input Enable	*(Figure 1)*			20		ns
Select Bus							
t_{CLR}	Clear Previous Chip Enable	*(Figure 2)*			25	50	ns

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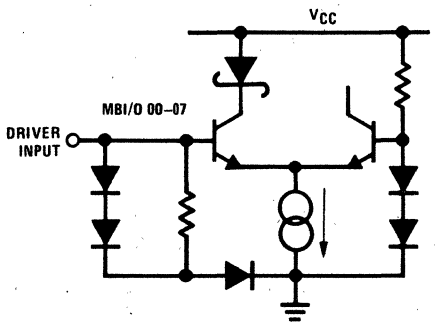
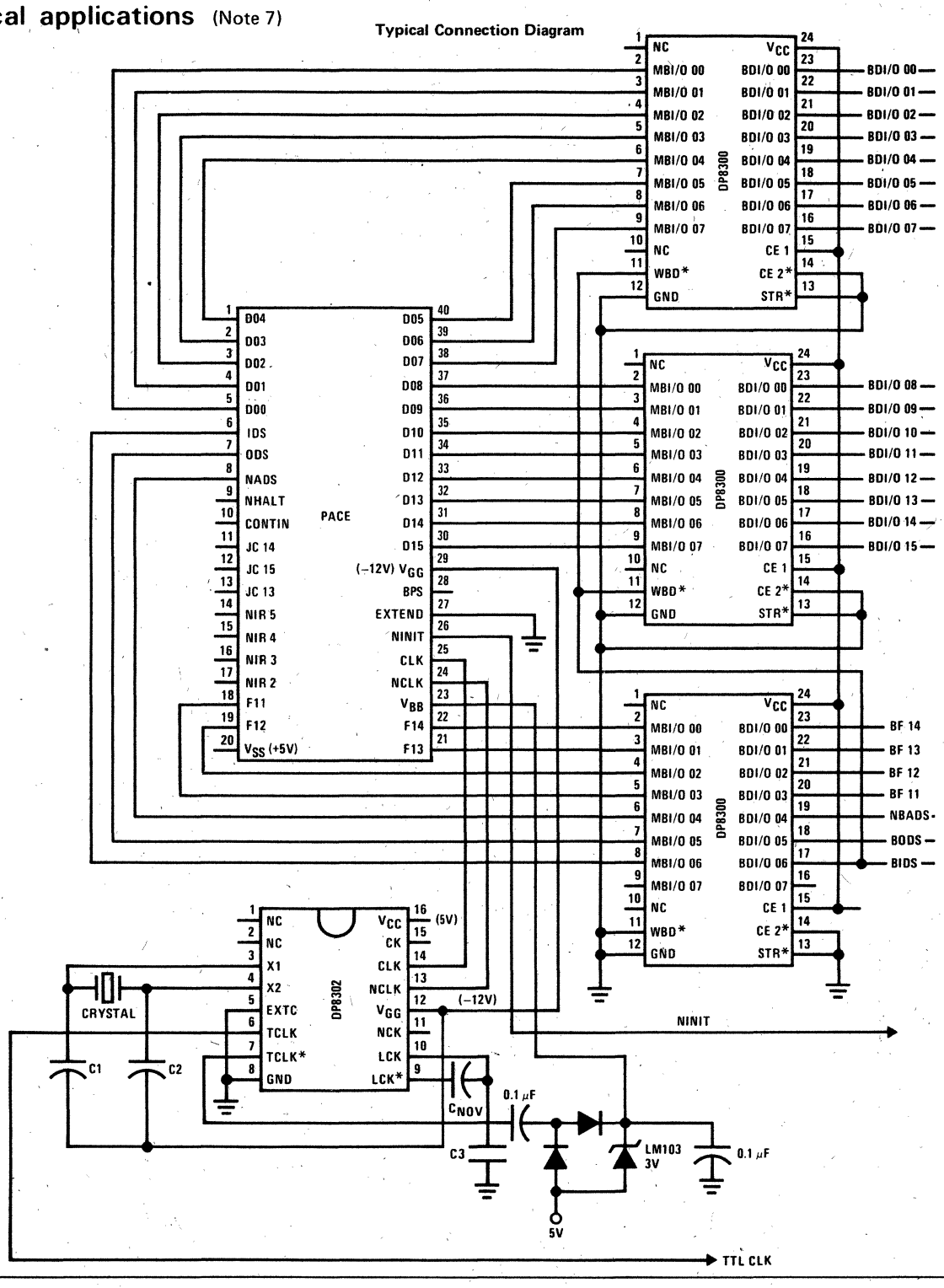
equivalent circuit

MOS Bus Driver Input



typical applications (Note 7)

Typical Connection Diagram



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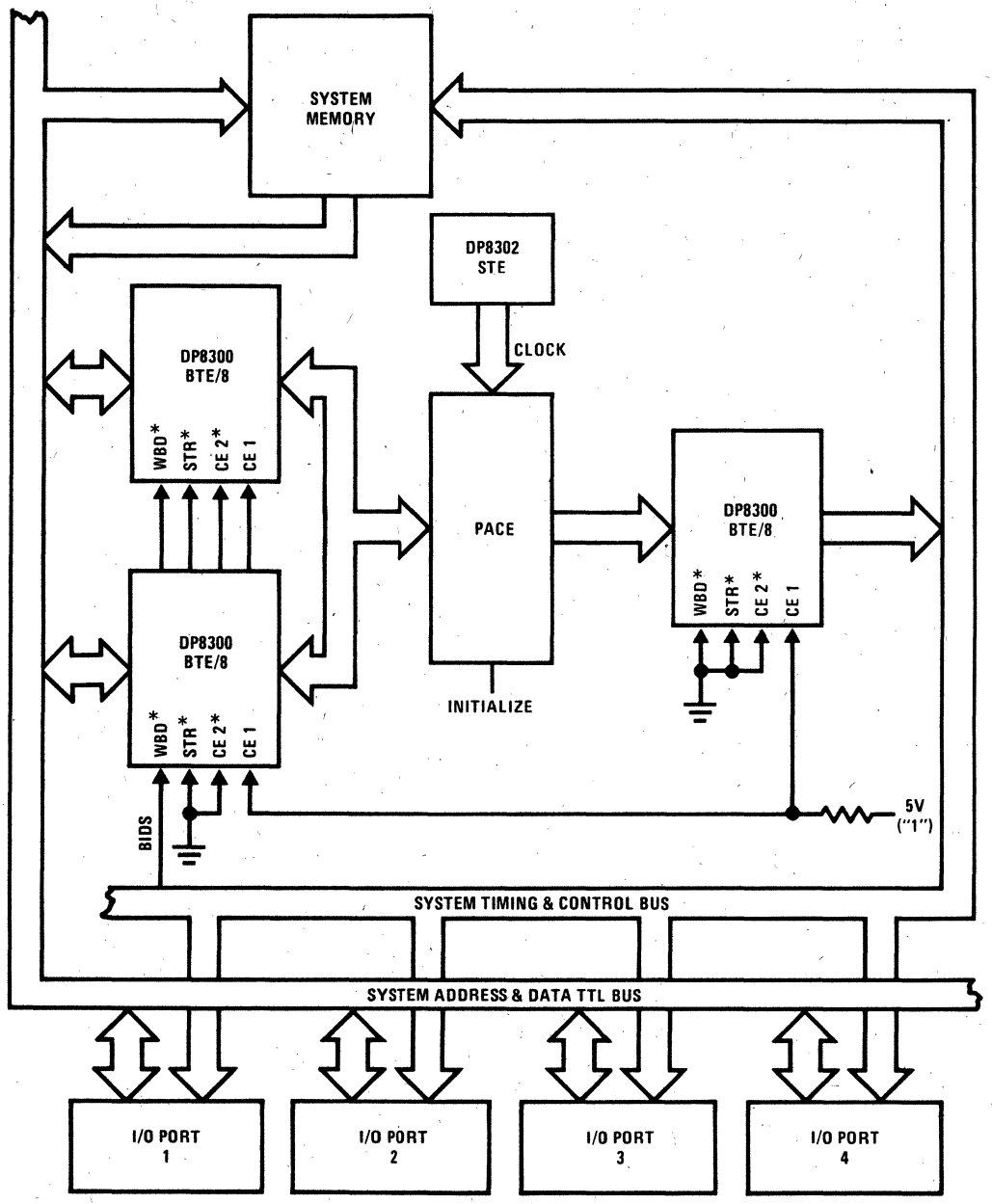
typical applications (Continued)

Multiplexed TTL System Bus*



*See Note 7

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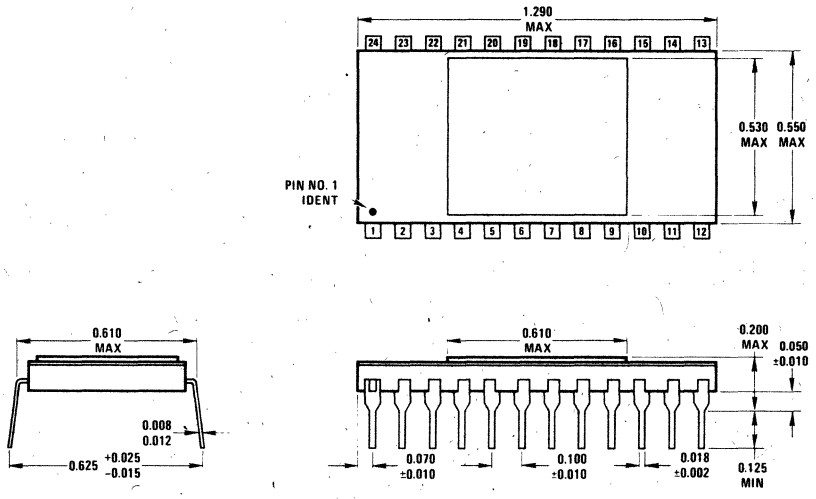
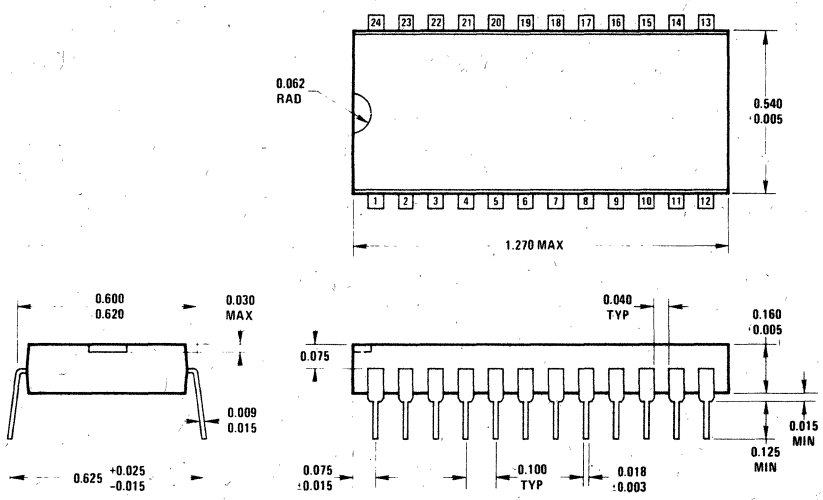
physical dimensions



Cavity Dual-In-Line Package (D)
Order Number DP8300D



Molded Dual-In-Line Package (N)
Order Number DP8300N

Manufactured under one or more of the following U.S. patents: 3083262, 3189758, 3231797, 3303356, 3317671, 3323071, 3381071, 3408542, 3421025, 3426423, 3440498, 3518750, 3519897, 3557431, 3560765, 3566218, 3571630, 3575609, 3579059, 3593069, 3597640, 3607469, 3617859, 3631312, 3633052, 3638131, 3648071, 3651565, 3693248.

National Semiconductor Corporation
2900 Semiconductor Drive, Santa Clara, California 95051, (408) 737-5000/TWX (910) 339-9240
National Semiconductor GmbH
808 Fuerstenfeldbruck, Industriestrasse 10, West Germany, Tele. (08141) 1371/Telex 05-27649
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DP8302 PACE system timing element (PACE STE)

general description

The PACE STE provides an oscillator, CPU clock driver, and TTL system clocks in a single 16-pin DIP. The STE is intended specifically for application in PACE microprocessor-based systems.

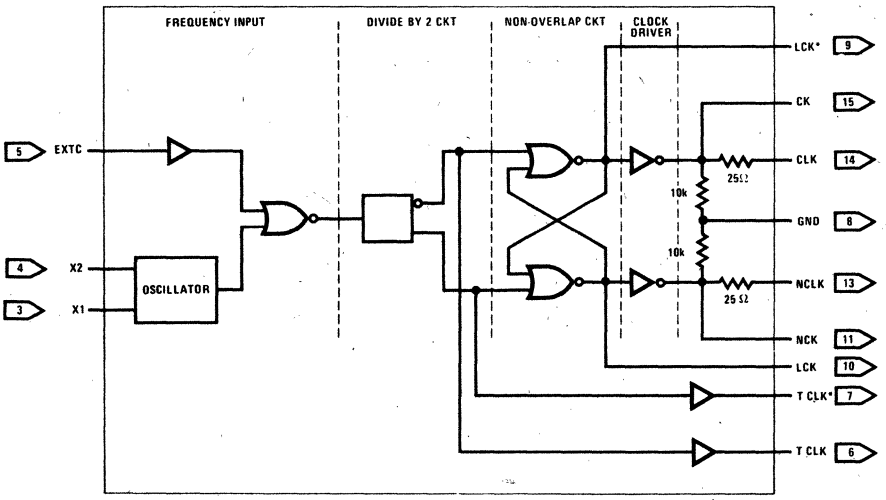
An external crystal provides frequency control. True and complemented non-overlapping clock outputs are generated at one-half the oscillator frequency. Non-overlap intervals may be controlled with a single external capacitor. Series damping resistors are provided on the MOS (CPU) clock outputs (CLK, NCLK).

TTL level system clock outputs are also provided to facilitate the synchronizing of system operations.

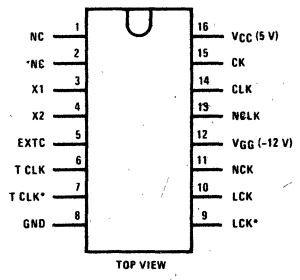
features

- Internal Oscillator Driven Directly from External Crystal, Minimizing Package Count
- External Oscillator Input Maximizes Application Flexibility
- TTL System Clocks Simplify Interfaces and Facilitate Synchronization of System Operations
- MOS Clock Outputs, No External MOS Clock Drivers Required
- High Voltage Output High Level (V_{CC} − 1.1 V) on TTL System Clocks

block and connection diagrams



Dual-In-Line Package



TOP VIEW

Signal* ≡ N Signal ≡
$\overline{\text{Signal}}$ ≡ Low Active Signal

NC = No Connection

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recommended crystal specifications

- At-cut crystal
- 4.0 MHz ± 0.1%, or 2.6667 MHz ± 0.1%, fundamental mode
- 5 mW maximum
- 150 Ω maximum series resistance

functional description

OSCILLATOR

The oscillator incorporates a low-power inverter biased in the linear region utilizing an internal feedback network. An external crystal is connected between pins X1 and X2 to provide frequency control. EXTC must be grounded for this operating mode. The circuit board traces connecting the crystal to pins X1 and X2 should be as short as possible and should be physically isolated from all high energy level switching signal traces, particularly the CPU MOS clock lines.

When an external oscillator is to be used in place of the internal crystal oscillator, pin X1 must be tied to V_{GG} and pin X2 must be left open. Then, EXTC may be used as a TTL input for the external oscillator.

DIVIDE AND SQUARING CIRCUIT

A flip-flop is used to provide a square wave clock signal by dividing the buffered oscillator output by two. The outputs of this circuit are buffered to provide TTL system clock signals which lead the MOS level clock outputs.

NON-OVERLAP CIRCUIT

The Divider output drives a cross-coupled latch containing a delay in the feedback path which insures non-overlapping MOS clock signals. The delay in the feedback path can be increased by connecting a capacitor between pins LCK and LCK*. The effect of the capacitor on increasing the non-overlap interval is shown in the Typical Characteristics section.

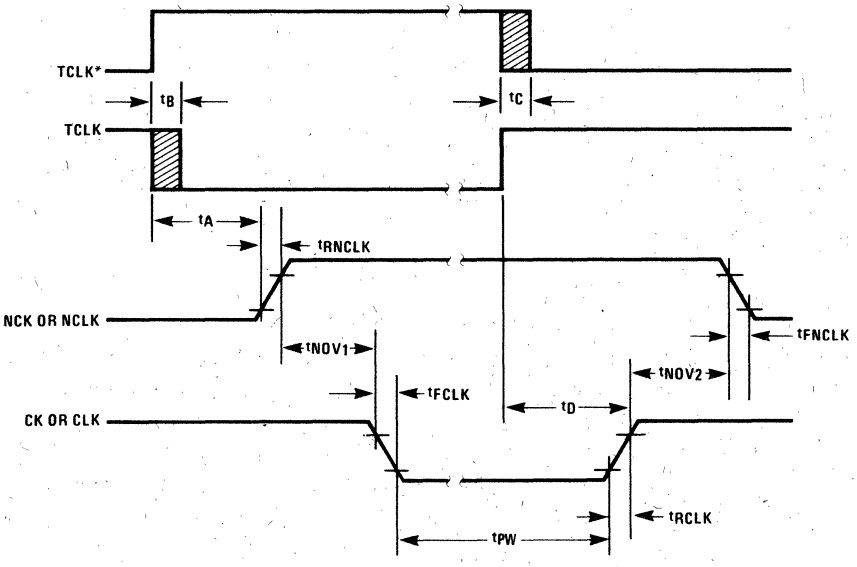
MOS CLOCK DRIVER

The MOS Clock Driver produces output voltage swings from the +5 V supply to the −12 V supply. CLK and NCLK outputs contain a 25 Ω series damping resistor, a typically optimum value for circuit board layouts with clock interconnect lines of less than two inches.

Undamped MOS clock outputs, CK and NCK, are also available in the event other values of series damping resistors are desired.

It is recommended that 0.1 μF high frequency capacitors be provided from V_{CC} to ground and from V_{GG} to ground immediately adjacent to the STE.

timing diagram



Times measured at 10% and 90%

$C_1 = C_2 = 60_{pf}$, $C_3 = 90_{pf}$, $C_{nov} = 40_{pf}$

Figure 1.

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absolute maximum ratings [1]

Supply Voltage (V_{CC}) . . . . . 7.0 V
(V_{GG}) . . . . . −15.0 V
Input Voltage . . . . . 5.5 V
Storage Temperature . . . . . −65°C to +150°C
Lead Temperature (soldering, 10 seconds) . . . . . 300°C

operating conditions

	Min.	Max.	Units
Supply Voltage (V_{CC})	4.75	5.25	V
(V_{GG})	−11.40	−12.6	V
Temperature	0	+70	°C

dc electrical characteristics (Notes 2 and 3)

Parameter	Conditions		Min.	Typ.	Max.	Units
OUTPUT SPECIFICATIONS:						
T CLK, T CLK*						
V_{OH} Logic "1" Output Voltage	V_{CC} = 4.75 V	I_{OH} = −1 mA		4.25		V
V_{OL} Logic "0" Output Voltage	V_{CC} = 4.75 V	I_{OL} = 32 mA				V
		I_{OL} = 50 mA				V
I_{OS} Output Short Circuit Current	(Note 4), V_{CC} = 5.25 V, V_O = 0			−33		mA
CK, NCK, CLK, NCLK						
V_{OH} Logic "1" Output Voltage	I_{OH} = −50 μA			4.0		V
V_{OL} Logic "0" Output Voltage	V_{CC} = 4.75 V, V_{GG} = −11.4 V	I_{OL} = 100 μA		V_{GG} + 0.1		V
		I_{OL} = 10 mA		V_{GG} + 0.2		V
INPUT SPECIFICATIONS						
EXTC						
V_{IH} Logic "1" Input Voltage						V
I_{IH} Logic "1" Input Current	V_{CC} = 5.25 V	V_{IN} = 2.4 V				μA
		V_{IN} = 5.5 V				mA
V_{IL} Logic "0" Input Voltage						V
I_{IL} Logic "0" Input Current	V_{CC} = 5.25 V	V_{IL} = 0.4 V				mA
V_{CLAMP} Input Clamp Diode	V_{CC} = 4.75 V	I_{IL} = −12 mA				V
POWER SUPPLY CURRENT						
I_{CC} Supply Current from V_{CC}	V_{CC} = 5.25 V					mA
I_{GG} Supply Current from V_{GG}	V_{GG} = −12.6 V					mA

ac electrical characteristics

T_A = 0°C to +70°C, V_{CC} − V_{GG} = +17 V ± 5%

Parameter	Conditions	Min.	Typ.	Max.	Units
t_{RCK}, t_{RNCK}	C_L = 80 pF Figure 1		20		ns
t_{FNCK}, t_{FCK}	C_L = 80 pF Figure 1		20		ns
t_{NOV1}, t_{NOV2}	C_L = 80 pF Figure 1		12		ns
t_A, t_D	C_L = 80 pF Figure 1		10		ns
t_B, t_C	C_L = 80 pF Figure 1		8		ns
t_{PW}	C_L = 80 pF Figure 1, Crystal Frequency = 4 MHz				ns
t_{PW}	C_L = 80 pF Figure 1, Crystal Frequency = 2.6667 MHz				ns
f_{MAX} Maximum Input Frequency					MHz

Notes:

1. "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.
2. Unless otherwise specified, min/max limits apply across the 0°C to +70°C temperature range and V_{CC} = 4.75 V to 5.25 V, V_{GG} = −11.4 V to −12.6 V power supply range. All typicals are given for V_{CC} = 5.0 V, V_{GG} = −12 V, and T_A = +25°C.
3. All currents into device pins are shown as positive; currents out of device pins are shown as negative. All voltages are references to ground unless otherwise noted.
4. Only one output at a time should be shorted.

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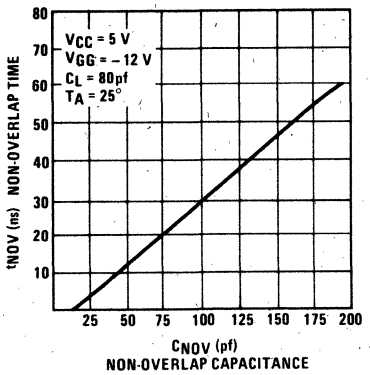
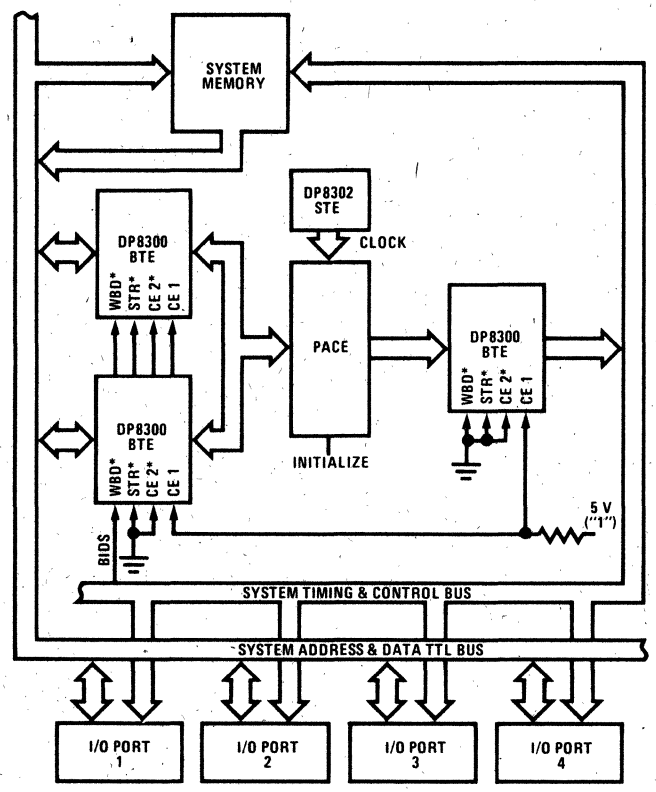
TYPICAL NON-OVERLAP TIME VS. NON-OVERLAP CAPICITOR



typical applications



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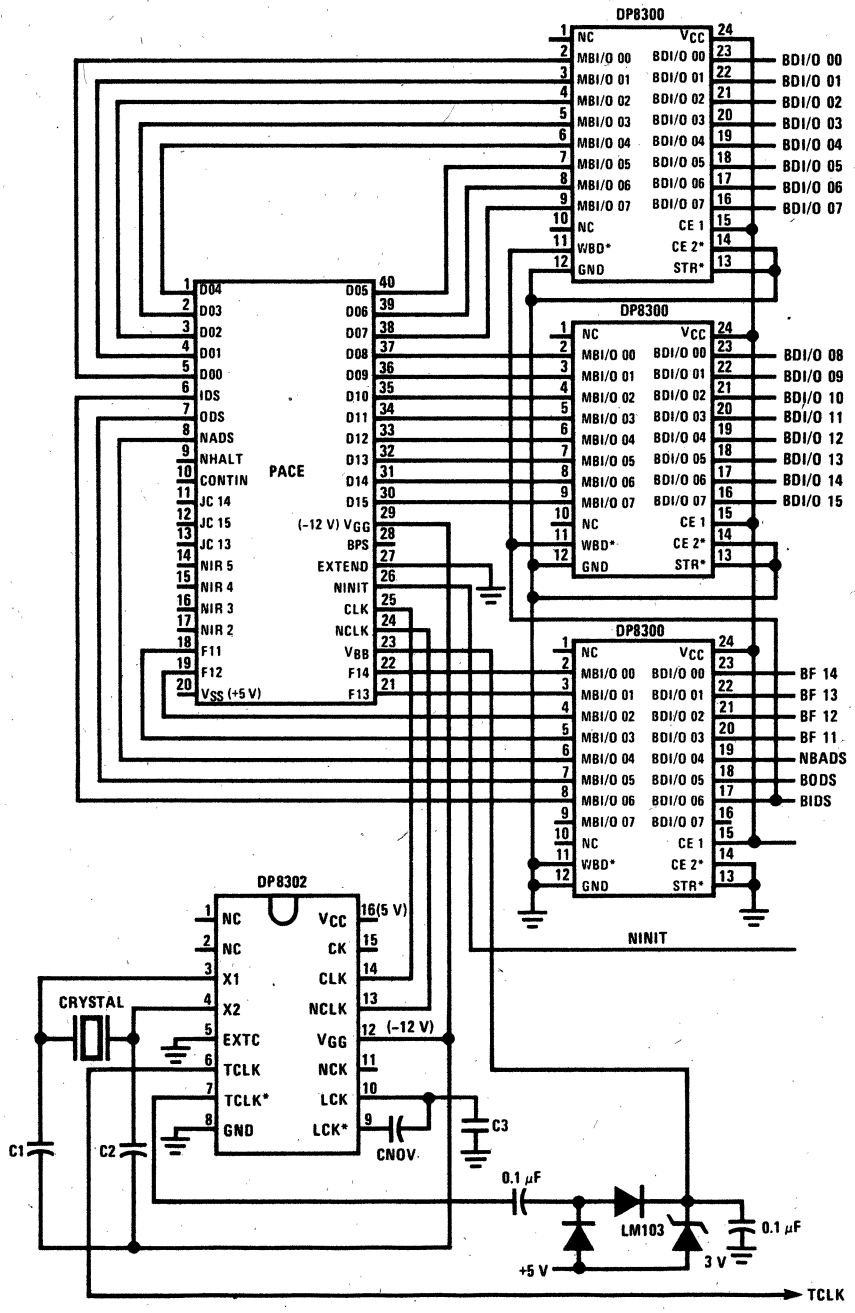
typical connection diagram



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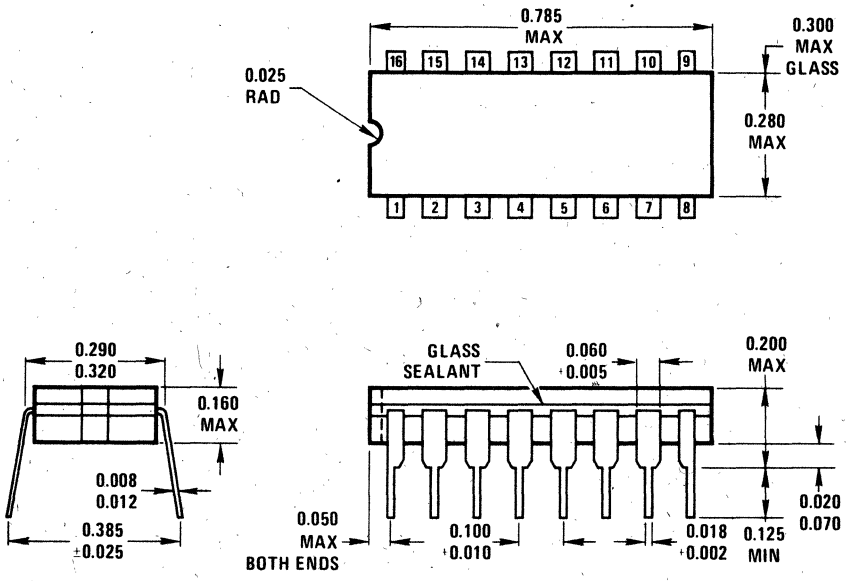
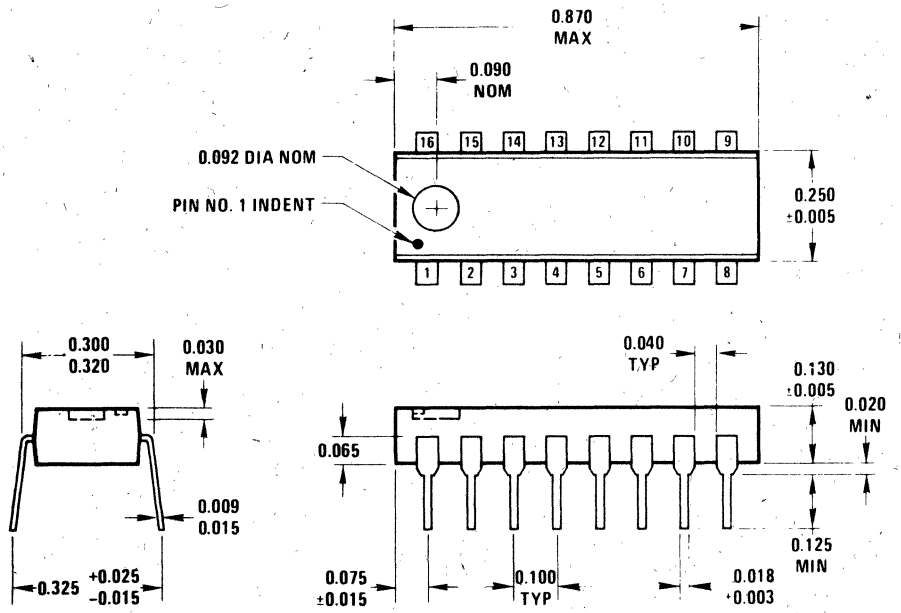
physical dimensions



ORDER NO. DP8302 J
16 PIN D PACKAGE



ORDER NO. DP8302 N
16 PIN D PACKAGE

Manufactured under one or more of the following U.S. patents: 3083262, 3189758, 3231797, 3303356, 3317671, 3323071, 3381071, 3408542, 3421025, 3426423, 3440498, 3518750, 3519897, 3557431, 3560765, 3566218, 3571630, 3575609, 3579059, 3593069, 3597640, 3607469, 3617859, 3631312, 3633052, 3638131, 3648071, 3651565, 3693248.

National Semiconductor Corporation
2900 Semiconductor Drive, Santa Clara, California 95051, (408) 737-5000/TWX (910) 339-9240
National Semiconductor GmbH
808 Fuerstenfeldbruck, Industriestrasse 10, West Germany, Tele. (08141) 1371/Telex 05-27649
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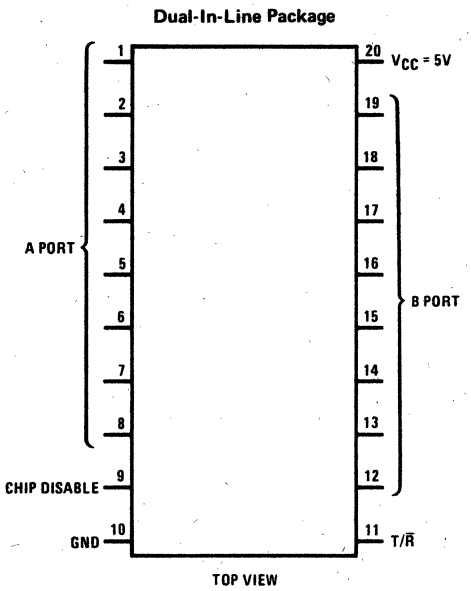
DP8304 8-bit bidirectional bus transceiver

general description

The DP8304 is an 8-bit bidirectional Bus transceiver able to drive a common Bus (B port) or 10 LS input loads (A port). Inputs to both ports are LSTTL. A chip disable provides TRI-STATE® to both ports when high, and data flow is controlled by the transmit/$\overline{\text{receive}}$ enable. Both outputs provide 3.6V V_{OH} when active. Signals are non-inverting for both ports. With T/$\overline{R}$ low data flows from B port to A port.

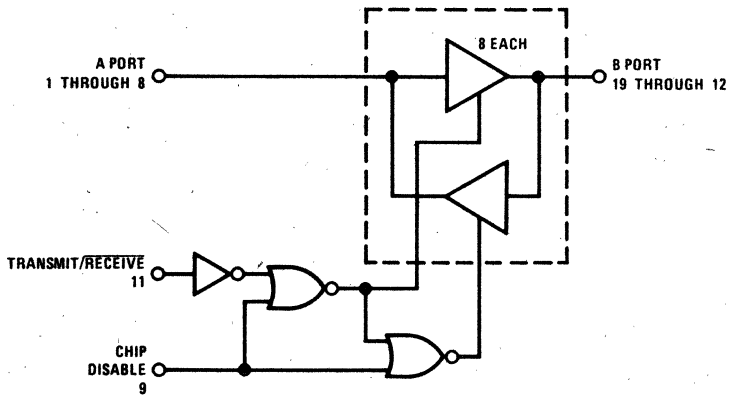
connection diagram



truth table

PIN DESCRIPTION	RECEIVE	TRANSMIT	DISABLE
Chip Disable	0	0	1
Transmit/$\overline{\text{Receive}}$	0	1	X
A Port	Out	In	TRI-STATE
B Port	In	Out	TRI-STATE

logic diagram



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DS0025/DS0025C two phase MOS clock driver

general description

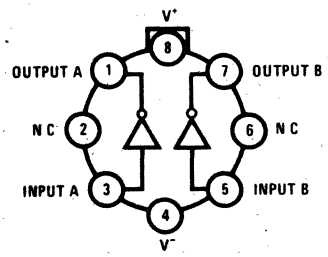
The DS0025/DS0025C is monolithic, low cost, two phase MOS clock driver that is designed to be driven by TTL/DTL line drivers or buffers such as the DM932, DS8830 or DM7440. Two input coupling capacitors are used to perform the level shift from TTL/DTL to MOS logic levels. Optimum performance in turn-off delay and fall time are obtained when the output pulse is logically controlled by the input. However, output pulse widths may be set by selection of the input capacitors eliminating the need for tight input pulse control.

features

- 8-lead TO-5 or 8-lead dual-in-line package
- High Output Voltage Swings—up to 30V
- High Output Current Drive Capability—up to 1.5A
- Rep. Rate: 1.0 MHz into > 1000 pF
- Driven by DM932, DS8830, DM7440 (SN7440)
- "Zero" Quiescent Power

connection diagrams

Metal Can Package

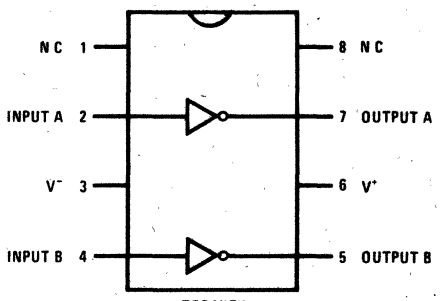


Note: Pin 4 connected to case.

TOP VIEW

Order Number DS0025H or DS0025CH
See Package 23

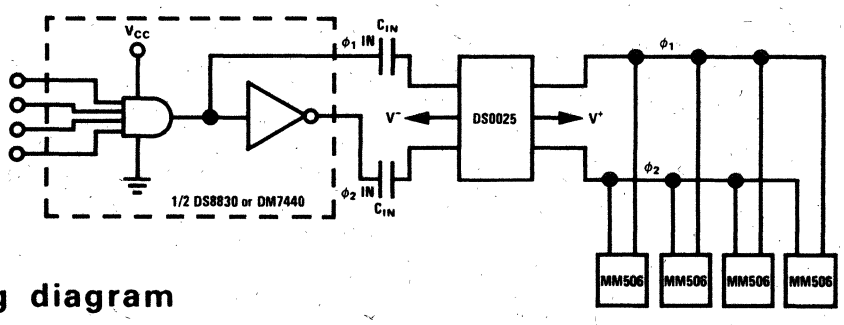
Dual-In-Line Package



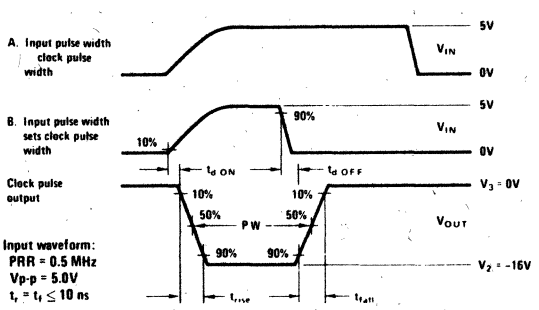
TOP VIEW

Order Number DS0025CN
See Package 12

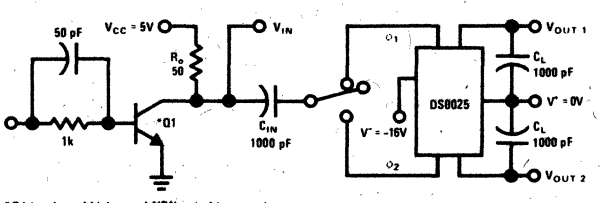
typical application



timing diagram



ac test circuit



*Q1 is selected high speed NPN switching transistor.

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Interface

DS0026, DS0056 5 MHz two phase MOS clock drivers

general description

DS0026/DS0056 are low cost monolithic high speed two phase MOS clock drivers and interface circuits. Unique circuit design provides both very high speed operation and the ability to drive large capacitive loads. The device accepts standard TTL/DTL outputs and converts them to MOS logic levels. They may be driven from standard 54/74 series and 54S/74S series gates and flip-flops or from drivers such as the DS8830 or DM7440. The DS0026 and DS0056 are intended for applications in which the output pulse width is logically controlled; i.e., the output pulse width is equal to the input pulse width.

The DS0026/DS0056 are designed to fulfill a wide variety of MOS interface requirements. As a MOS clock driver for long silicon-gate shift registers, a single device can drive over 10k bits at 5 MHz. Six devices provide input address and precharge drive for a 8k by 16-bit 1103 RAM memory system. Information on the correct usage of the DS0026 in these as well as other systems is included in the application note AN-76A.

The DS0026 and DS0056 are identical except each driver in the DS0056 is provided with a V_{BB} connection to supply a higher voltage to the output stage. This aids in pulling up the output when it is in the high state. An external resistor tied between these extra pins and a supply higher than V^+ will cause the output to pull up to $(V^+ - 0.1V)$ in the off state.

For DS0056 applications, it is required that an external resistor be used to prevent damage to the device when the driver switches low. A typical V_{BB} connection is shown on the next page.

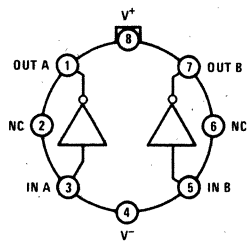
These devices are available in 8-lead TO-5, one watt copper lead frame 8-pin mini-DIP, and one and a half watt ceramic DIP, and TO-8 packages.

features

- Fast rise and fall times—20 ns with 1000 pF load
- High output swing—20V
- High output current drive—±1.5 amps
- TTL/DTL compatible inputs
- High rep rate—5 to 10 MHz depending on power dissipation
- Low power consumption in MOS "0" state—2 mW
- Drives to 0.4V of GND for RAM address drive

connection diagrams (Top Views)

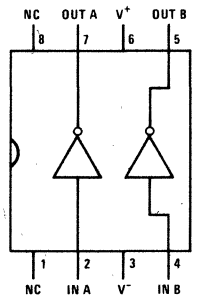
TO-5 Package



Note: Pin 4 connected to case.

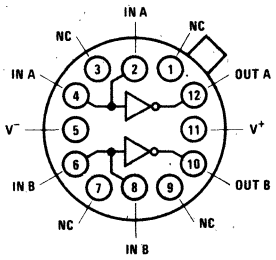
Order Number DS0026H or DS0026CH
See Package 23

Dual-In-Line Package



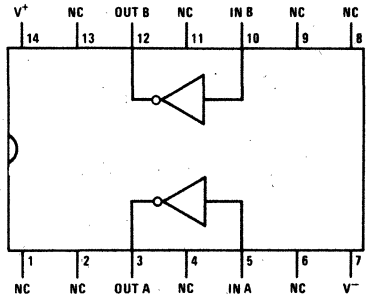
Order Number DS0026CN
See Package 12

TO-8 Package



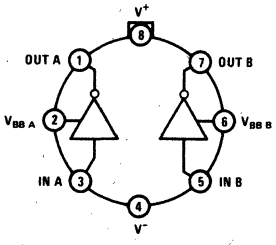
Order Number DS0026G or DS0026CG
See Package 25

Dual-In-Line Package



Order Number DS0026J, DS0026CJ or DS0026W
See Package 9 or 27

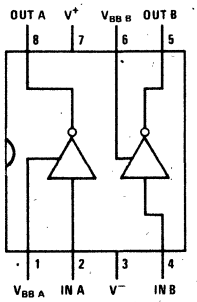
TO-5 Package



Note: Pin 4 connected to case.

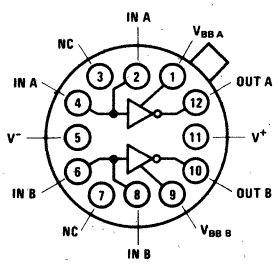
Order Number DS0056H or DS0056CH
See Package 23

Dual-In-Line Package



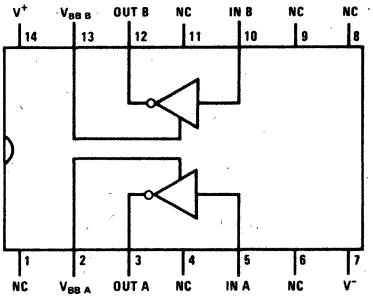
Order Number DS0056CN
See Package 12

TO-8 Package



Order Number DS0056G or DS0056CG
See Package 25

Dual-In-Line Package



Order Number DS0056J or DS0056CJ
See Package 9

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DS1603/DS3603, DS3604, DS55107/DS75107, DS55108/DS75108, DS75207, DS75208 dual line receivers

general description

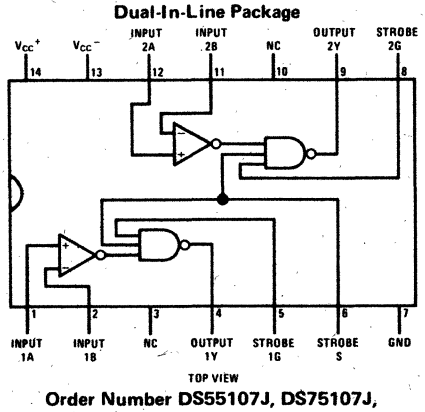
The nine products described herein are TTL compatible dual high speed circuits intended for sensing in a broad range of system applications. While the primary usage will be for line receivers or MOS sensing, any of the products may effectively be used as voltage comparators, level translators, window detectors, transducer preamplifiers, and in other sensing applications. As digital line receivers the products are applicable with the DS55109/DS75109 and DS55110/DS75110 companion drivers, or may be used in other balanced or unbalanced party-line data transmission systems. The improved input sensitivity and delay specifications of the DS75207, DS75208 and DS3604 make them ideal for sensing high performance MOS memories as well as high sensitivity line receivers and voltage comparators. TRI-STATE® products enhance bused organizations.

features

- Diode protected input stage for power "OFF" condition
- 17 ns typ high speed
- TTL compatible
- ±10 mV or ±25 mV input sensitivity
- ±3V input common-mode range
- High input impedance with normal V_{CC}, or V_{CC} = 0V
- Strobes for channel selection
- TRI-STATE outputs for high speed buses
- Dual circuits
- Sensitivity gntd. over full common-mode range
- Logic input clamp diodes—meets both "A" and "B" version specifications
- ±5V standard supply voltages

connection diagrams

Dual-In-Line Package



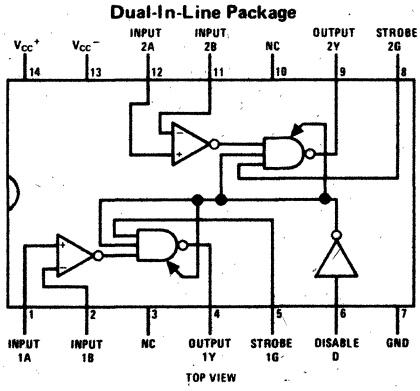
TOP VIEW

Order Number DS55107J, DS75107J, DS55108J, DS75108J, DS75207J or DS75208J
See Package 9

Order Number DS75107N, DS75108N, DS75207N or DS75208N
See Package 14

Order Number DS55107W or DS55108W
See Package 27

Dual-In-Line Package



TOP VIEW

Order Number DS1603J, DS3603J DS3604J or DS1603W
See Package 9 or 27

Order Number DS3603N or DS3604N
See Package 14

product selection guide

TEMPERATURE→ / PACKAGE→	$-55°C \leq T_A \leq +125°C$ CAVITY DIP	$0°C \leq T_A \leq +70°C$ CAVITY OR MOLDED DIP	
INPUT SENSITIVITY→ / OUTPUT LOGIC↓	±25 mV	±25 mV	±10 mV
TTL Active Pull-up	DS55107	DS75107	DS75207
TTL Open Collector	DS55108	DS75108	DS75208
TTL TRI-STATE	DS1603	DS3603	DS3604

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Interface

DS1605/DS3605, DS1606/DS3606, DS1607/DS3607, DS1608/DS3608 hex MOS sense amplifiers (MOS to TTL converters)

general description

The DS3605 series is a new series of programmable hex MOS sense amplifiers featuring high speed direct MOS sense capability with high impedance states to allow use of a common bus line. The DS1605/DS3605 and the DS1606/DS3606 have TRI-STATE® outputs. The DS1607/DS3607 and DS1608/DS3608 have both TRI-STATE inputs and outputs. High impedance states are controlled by an enable input.

Input current threshold (the level at which the output changes state) is determined by the current at the programming pin. The current threshold is 100μA with the programming pin grounded and 250μA with the pin unconnected. The threshold can be set from 100μA to 300μA by connecting a resistor from the pin to ground, and set above 300μA by connecting a resistor from the pin to the positive supply.

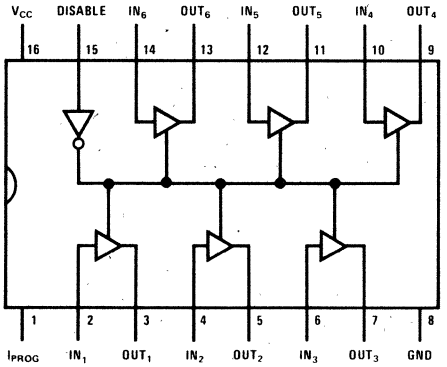
Outputs are high current drivers capable of sinking 50 mA in the low state and sourcing 5 mA in the high state.

features

- Non-inverting inputs (DS1605/DS3605, DS1607/DS3607)
- Inverting inputs (DS1606/DS3606, DS1608/DS3608)
- No external components required (direct MOS sensing)
- Programmable input thresholds
- Current sensing—100μA minimum
- 50 mA drive capability
- TRI-STATE control
- Single 5V supply
- 15 ns typical propagation delay (DS3605)

connection diagram

Dual-In-Line Package



TOP VIEW

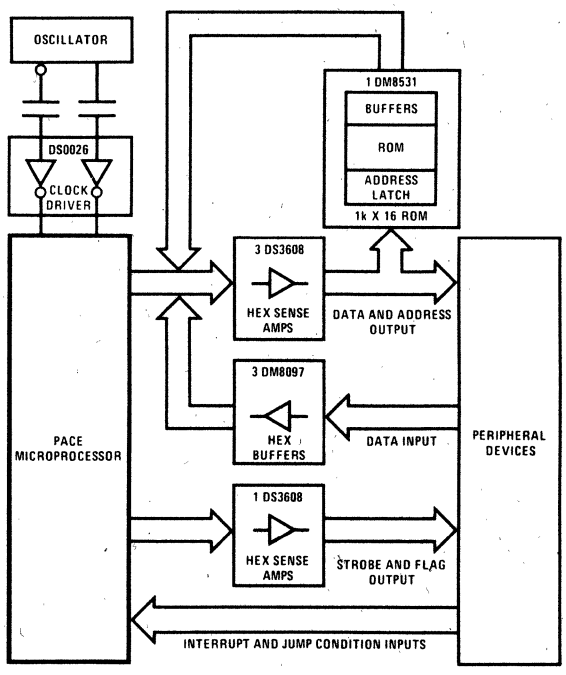
ordering information

ORDER NUMBERS	PACKAGE
DS1605J, DS1606J, DS1607J, DS1608J	Cavity DIP (J)
DS3605J, DS3606J, DS3607J, DS3608J	Cavity DIP (J)
DS3605N, DS3606N, DS3607N, DS3608N	Molded DIP (N)

See Package 10 or 15

typical application

PACE Interface



DS3608 shown as an interface between the PACE microprocessor and TTL data bus and I/O bus.

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DS1640/DS3640, DS1670/DS3670 quad MOS TRI-SHARE™ port drivers

general description

The DS1640/DS3640 and DS1670/DS3670 are quad MOS TRI-SHARE port drivers with outputs designed to drive large capacitive loads up to 500 pF associated with MOS memory systems. PNP input transistors are employed to reduce input current, allowing the large fan-out to these drivers needed in memory systems. The circuit has Schottky-clamped transistor logic for minimum propagation delay.

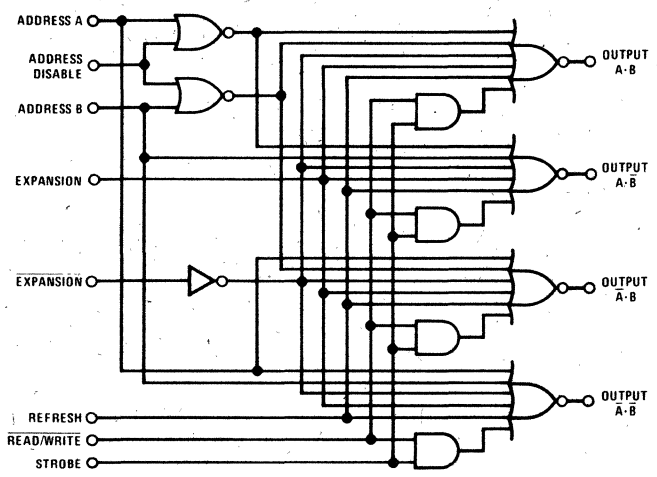
The DS1640/DS3640 has a 15 Ω resistor in series with the outputs to dampen transients caused by the fast switching output circuit. The DS1670/DS3670 has a direct, low impedance output source for use with or without an external resistor.

The DS1640/DS1670 has two address inputs which decode to one-of-four-high outputs. Provisions are made for address expansion. For example, two packages may be used to implement a three-input, eight-output decoder. Also included is a refresh control, read/write, and strobe input. These functions are required by the MM5270 4k TRI-SHARE MOS RAM.

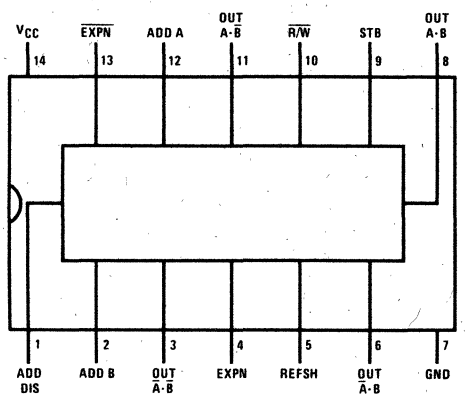
features

- TRI-SHARE port driver for MM5270 RAM
- TTL/DTL compatible inputs
- PNP inputs minimize loading
- Capacitance-driving outputs
- Built-in damping resistor (DS1640/DS3640)

logic and connection diagrams

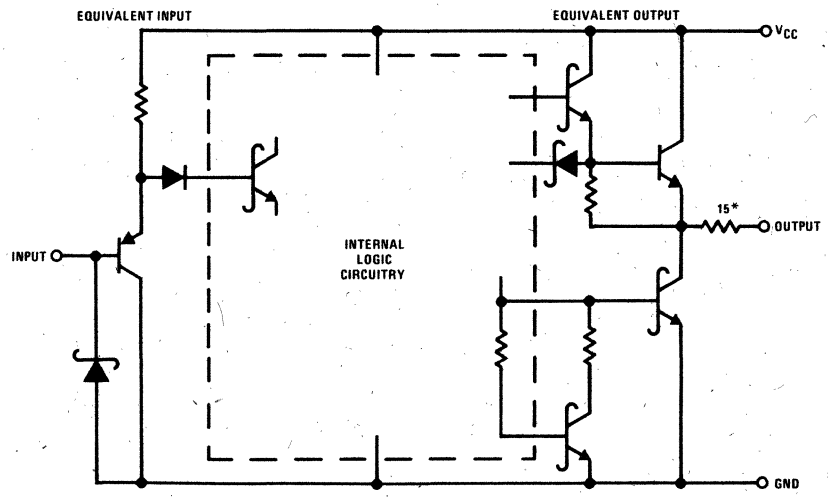


Dual-In-Line Package



TOP VIEW

schematic diagram



*DS1640/DS3640 only

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DS1642/DS3642, DS1672/DS3672
dual bootstrapped TTL to MOS clock drivers

general description

The DS1672 is a dual bipolar-to-MOS clock driver designed to provide high output current and voltage capabilities necessary for driving high capacitance (up to 500 pF) MOS memory systems. The circuit needs only one power supply, (12V typical). This feature greatly reduces high stand-by power levels and at the same time simplifies system deisgn.

The circuit also features output bootstrapping, eliminating the need for an additional supply to provide a higher voltage to the output stage. The function is accomplished by connecting a small value capacitor (typically 200 pF) from the output to the bootstrap pin on each driver.

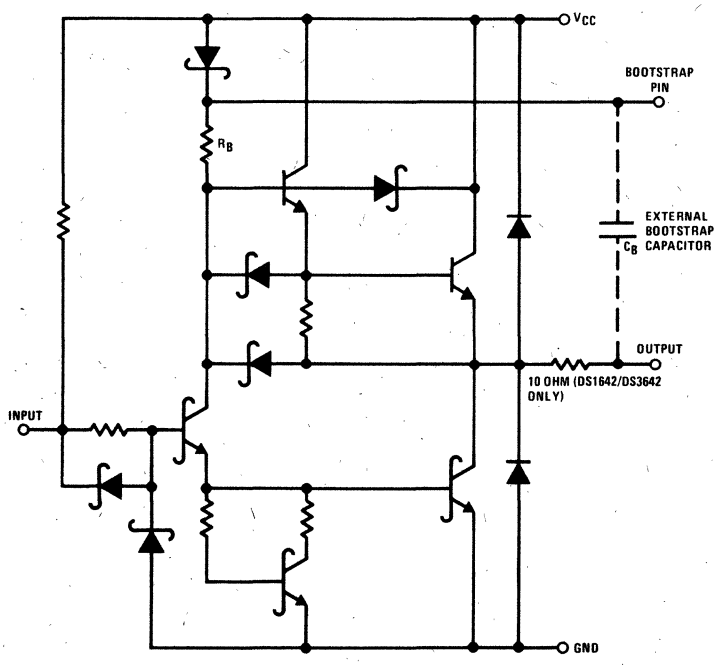
The circuit has Schottky-clamped transistor logic for minimum propagation delay. Typical stand-by power (output low) is 48 mW per driver. A fail-safe condition is provided in the circuit, so if the input is opened the output assumes the logic "0" state.

The DS1642/DS3642 has a 10 Ω resistor in series with each output to dampen transients caused by the fast-switching output. The DS1672/DS3672 has a direct low impedance output for use with or without an external resistor.

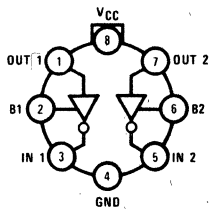
features

- High output voltage capability 13.2V
- TTL/DTL compatible inputs
- High speed operation
- Bootstrapping eliminates extra supplies—reduces power
- Low stand-by power 48 mW/driver
- Built-in 10 Ω damping resistor (DS1642/DS3642)

schematic and connection diagrams

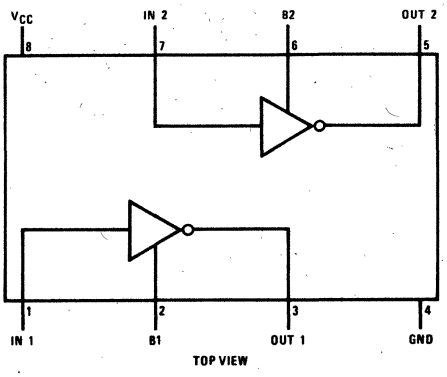


Metal Can Package



TOP VIEW

Dual-In-Line Package



TOP VIEW

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DS1645/DS3645, DS1675/DS3675 hex TRI-STATE® TTL to MOS latch/drivers

general description

The DS1645/DS3645 and DS1675/DS3675 are hex MOS latch/drivers with outputs designed to drive large capacitive loads up to 500 pF associated with MOS memory systems. PNP input transistors are used to reduce input currents, allowing the large fan-out to these drivers needed in memory systems. The circuit has Schottky-clamped transistor logic for minimum propagation delay, and TRI-STATE® outputs which allow bus operation.

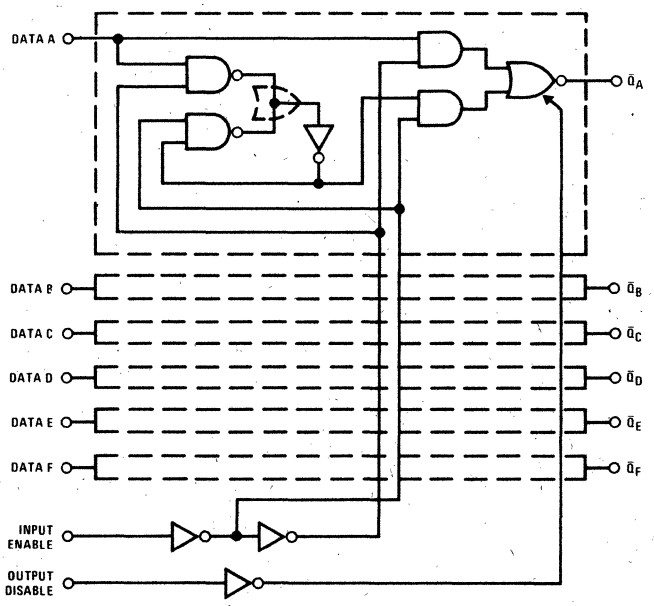
The DS1645/DS3645 has a 15 Ω resistor in series with the outputs to dampen transients caused by the fast switching output circuit. The DS1675/DS3675 has a direct, low impedance output for use with or without an external resistor.

The circuit employs a fall-through-latch which captures the data in parallel with the output, thereby eliminating the delay normally encountered in other latch circuits. The DS1645/DS3645 and DS1675/DS3675 may be used for input address lines or input/output data lines of a MOS memory system.

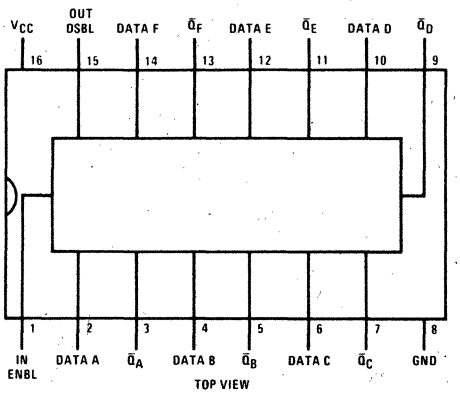
features

- TTL/DTL compatible inputs
- PNP inputs minimize loading
- Capacitance-driving outputs
- TRI-STATE outputs
- Built-in damping resistor (DS1645/DS3645)

logic and connection diagrams



Dual-In-Line Package



truth table

INPUT ENABLE	OUTPUT DISABLE	DATA	OUTPUT	OPERATION
1	0	1	0	Data Feed-Through
1	0	0	1	Data Feed-Through
0	0	X	Q	Latched to Data Present when Enable Went Low
X	1	X	Hi-Z	High Impedance Output

X = Don't care
Hi-Z = TRI-STATE mode

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Memory/Clock Drivers

Advance Information*

DS1646/DS3646, DS1676/DS3676 6-bit TRI-STATE® MOS refresh counter/driver

general description

The DS1646/DS3646 and DS1676/DS3676 are 6-bit refresh counters with outputs designed to drive large capacitive loads up to 500 pF associated with MOS memory systems. PNP input transistors are employed to reduce input currents. The circuit has Schottky-clamped transistor logic for minimum propagation delay, and TRI-STATE outputs allow it to be used on common data buses.

The DS1646/DS3646 has a 15Ω resistor in series with the outputs to dampen transients caused by the fast switching output circuit. The DS1676/DS3676 has a direct, low impedance output, for use with or without an external resistor.

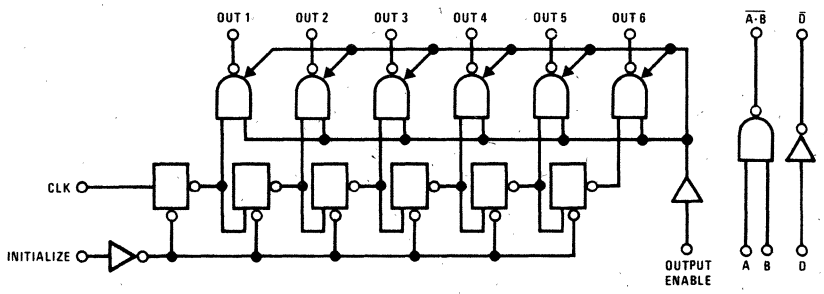
The counter uses as its input the RAM clock signal, and with each clock input, it advances the count by one, thus generating a new refresh address.

Extra pins in the package are used for a 2-input NAND gate and a 2-input NOR gate, both of which have capacitive drive outputs.

features

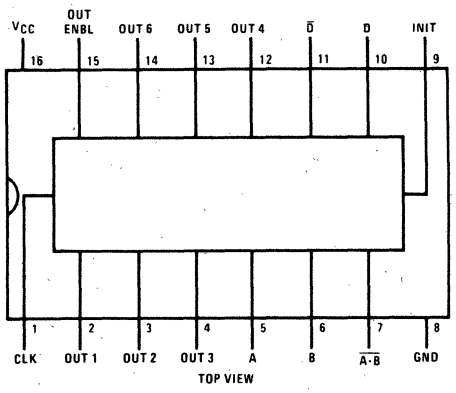
- Circuit counts when clock goes high
- TTL/DTL compatible inputs
- PNP inputs minimize loading
- Capacitance-driver outputs
- TRI-STATE outputs
- Extra gates on unused pins
- Built-in damping resistor (DS1646/DS3646)
- Initialize input

logic diagram



connection diagram

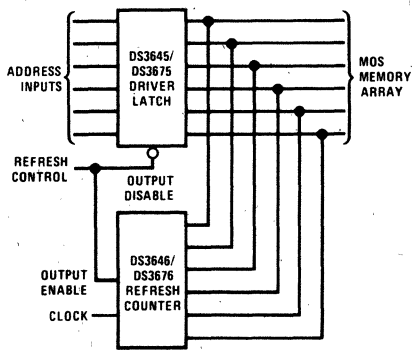
Dual-In-Line Package



Order Number DS1646J, DS1676J, DS3646J, DS3676J, DS3646N, or DS3676N
See Package 10 or 15

typical application

The DS1646/DS3646 and DS1676/DS3676 have TRI-STATE outputs which can be tied to the outputs of another TRI-STATE driver. The refresh counter can control the address lines into a memory array during a short refresh cycle, and then return to the high-impedance state to allow the primary driver to control the address lines.



*Specifications may change.

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Interface

Advance Information*

DS1647/DS3647, DS1677/DS3677, DS16147/DS36147, DS16177/DS36177 quad TRI-STATE® MOS memory I/O registers

general description

The DS1647/DS3647 series are 4-bit I/O buffer registers intended for use in MOS memory systems. The circuits employ a fall-through latch for data storage. This method of latching captures the data in parallel with the output, thus eliminating the delays encountered in other designs. The circuits use Schottky-clamped transistor logic for minimum propagation delay and employ PNP input transistors so that input currents are low, allowing large fan-out to these circuits needed in a memory system.

Two pins per bit are provided, and data transfer is bi-directional so that the register can handle both input and output data. The direction of data flow is controlled through the input enables. The latch control, when taken low, will cause the register to hold the data present at that time and display it at the outputs. Data can be latched into the register independent of the output disables or EXPANSION input. Either or both of the outputs may be taken to the high-impedance state with the output disables. The EXPANSION pin disables both outputs to facilitate multiplexing with other I/O registers on the same data lines.

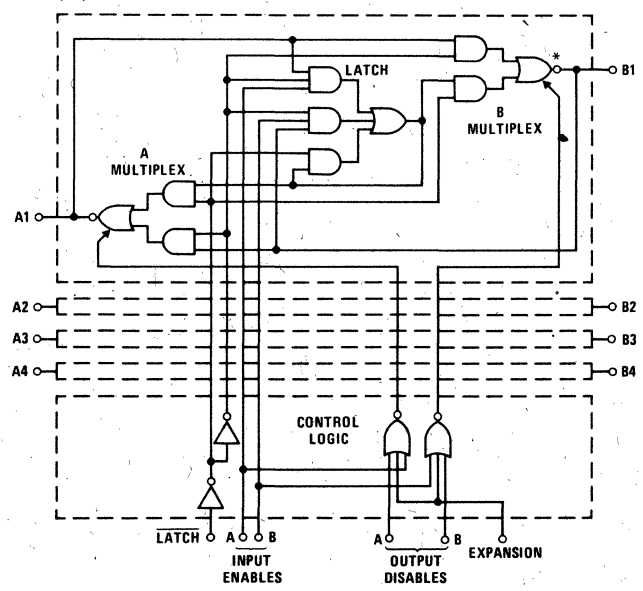
The "B" port outputs in the DS16147/DS36147 and DS16177/DS36177 are open collectors, and in the DS1647/DS3647 and DS1677/DS3677 they are TRI-STATE. The "B" port outputs are also designed for use in bus organized data transmission systems and can sink 50 mA and source −5.2 mA. The "A" port outputs in all four types are TRI-STATE.

Data going from port "A" to port "B" is inverted in the DS1647/DS3647 and DS16147/DS36147 and is not inverted in the DS1677/DS3677 and DS16177/DS36177. Data going from port "B" to port "A" is inverted in all four types.

features

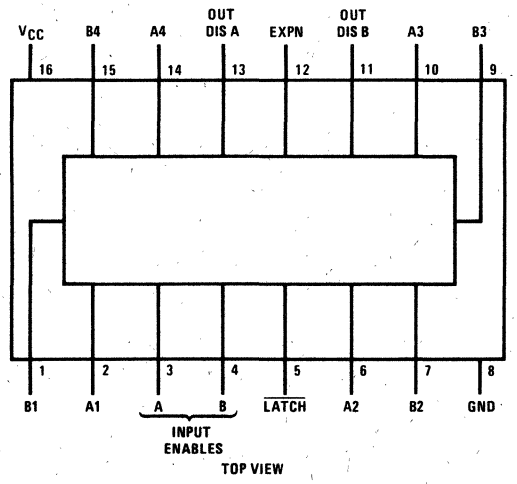
- PNP inputs minimize loading
- Fall-through latch design
- High speed circuitry
- TRI-STATE outputs
- EXPANSION control
- Bi-directional data flow
- TTL/DTL compatible
- Transmission line driver output

logic and connection diagrams



*Inverting DS1647/DS3647 and DS16147/DS36147 only

Dual-In-Line Package



Order Number DS1647D, DS3647D, DS1677D, DS3677D, DS16147D, DS36147D, DS16177D, DS36177D, DS3647N, DS3677N, DS36147N or DS36177N

*Specifications may change.

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DS1648/DS3648, DS1678/DS3678
TRI-STATE® TTL to MOS multiplexer/drivers

general description

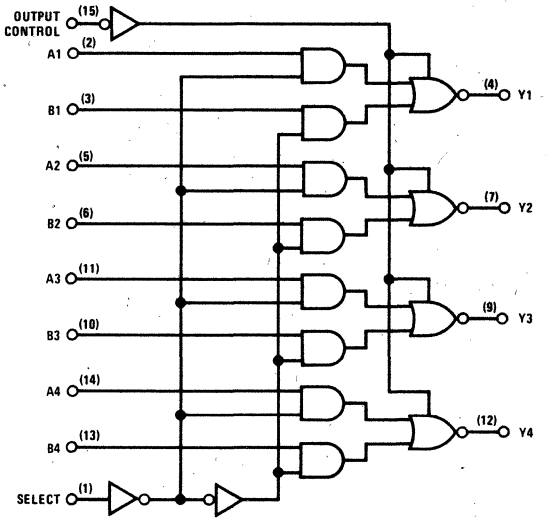
The DS1648/DS3648 and DS1678/DS3678 are quad 2-input multiplexers with TRI-STATE outputs designed to drive the large capacitive loads (up to 500 pF) associated with MOS memory systems. A PNP input structure is employed to minimize input currents so that driver loading in large memory systems is reduced. The circuit employs Schottky-clamped transistors for high speed and TRI-STATE outputs for bus operation.

The DS1648/DS3648 has a 15 Ω resistor in series with the outputs to dampen transients caused by the fast-switching output. The DS1678/DS3678 has a direct, low impedance output for use with or without an external resistor.

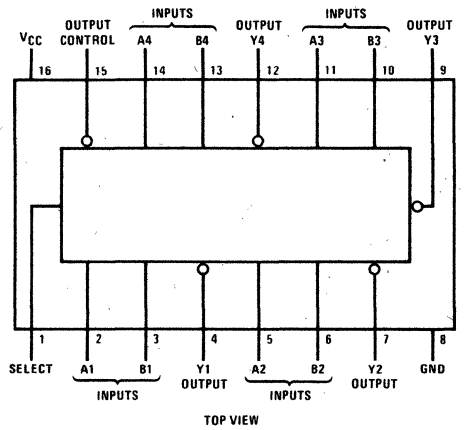
features

- TRI-STATE outputs interface directly with system bus
- Schottky-clamped for better ac performance
- PNP inputs to minimize input loading
- DTL and TTL compatible
- High-speed capacitive load drivers
- Built-in damping resistor (DS1648/DS3648 only)

logic and connection diagrams

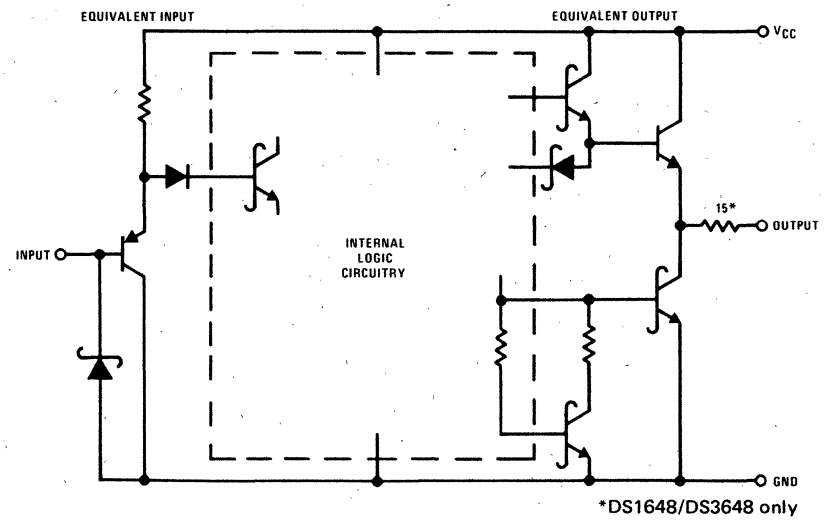


Dual-In-Line Package



TOP VIEW

schematic diagram



*DS1648/DS3648 only

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DS1649/DS3649, DS1679/DS3679 hex TRI-STATE® TTL to MOS drivers

general description

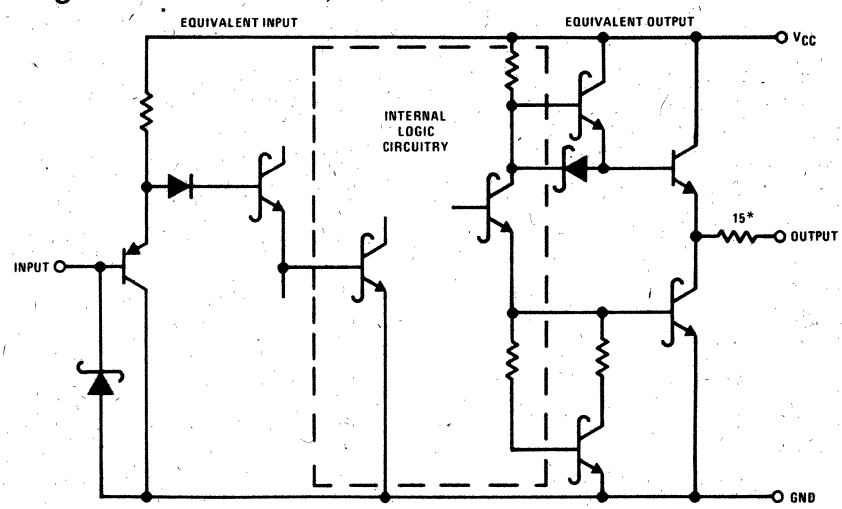
The DS1649/DS3649 and DS1679/DS3679 are Hex TRI-STATE MOS drivers with outputs designed to drive large capacitive loads up to 500 pF associated with MOS memory systems. PNP input transistors are employed to reduce input currents allowing the large fan-out to these drivers needed in memory systems. The circuit has Schottky-clamped transistor logic for minimum propagation delay, and TRI-STATE outputs for bus operation.

The DS1649/DS3649 has a 15 Ω resistor in series with the outputs to dampen transients caused by the fast-switching output. The DS1679/DS3679 has a direct low impedance output for use with or without an external resistor.

features

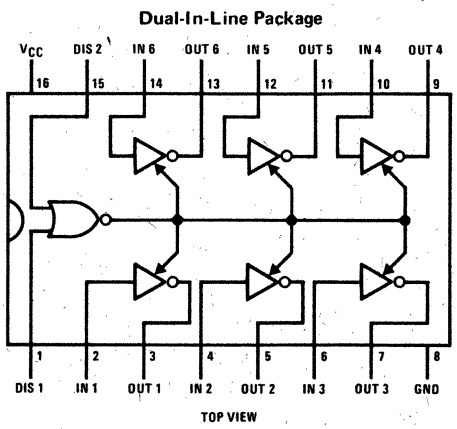
- High speed capabilities
  - Typ 9 ns driving 50 pF
  - Typ 30 ns driving 500 pF
- TRI-STATE outputs for data bussing
- Built-in 15 Ω damping resistor (DS1649/DS3649)
- Same pin-out as DM8096 and DM74366

schematic diagram

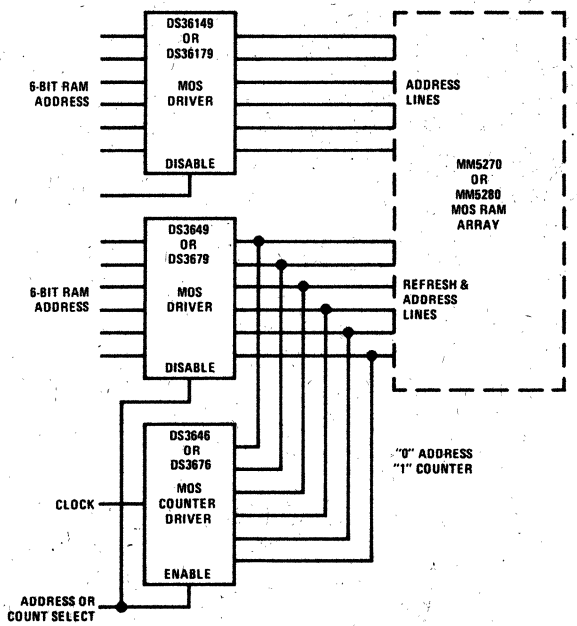


*DS1649/DS3649 only

connection diagram



typical application



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Interface
Advance Information*

DS1671/DS3671 bootstrapped two phase MOS clock driver

general description

The DS1671/DS3671 is a high speed dual MOS clock driver and interface circuit. Unique circuit design provides both very high speed operation and the ability to drive large capacitive loads. The device accepts standard TTL/DTL outputs and converts them to MOS logic levels. It may be driven from standard 54/74 and 54S/74S series gates and flip-flops or from drivers such as the DS8830 or DM7440. The circuit can be used in both P-channel and N-channel MOS memory system drive applications.

The DS1671/DS3671 is intended to fulfill a wide variety of MOS interface requirements. As a MOS clock driver for long silicon gate shift registers, a single device can drive over 10k bits at 5 MHz. Six devices provide input address and precharge drive for an 8k by 16-bit 1103 RAM memory system.

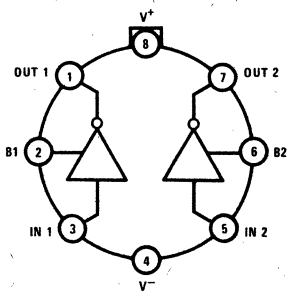
Each driver uses output bootstrapping to provide a higher voltage to the output stage, thus eliminating the need for an additional V_{DD} supply. The bootstrapping function is accomplished by connecting a small value capacitor (typically 200 pF) from each output to each drivers bootstrap node.

features

- Fast rise and fall times—20 ns with 1000 pF load
- High output swing—20V
- High output current drive—±1.5A
- TTL/DTL compatible inputs
- High rep rate—5 to 10 MHz depending on power dissipation
- Low power consumption in MOS "0" state—2 mW
- Swings to 0.4V of GND for RAM address drive

connection diagrams

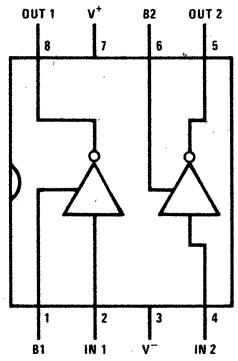
Metal Can Package



TOP VIEW

Order Number DS1671H or DS3671H
See Package 23

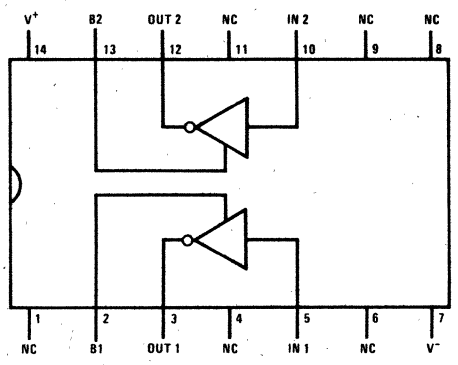
Dual-In-Line Package



TOP VIEW

Order Number DS3671N
See Package 12

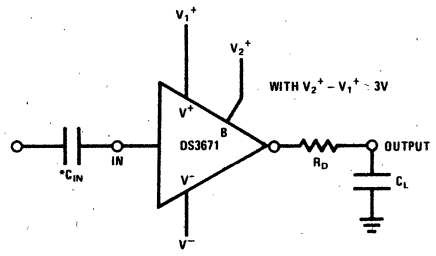
Dual-In-Line Package



TOP VIEW

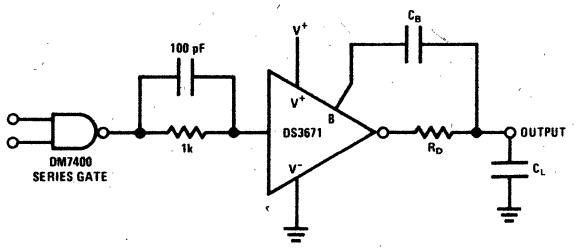
Order Number DS1671J or DS3671J
See Package 9

typical applications



*SEE GRAPH FOR VALUE

DS3671 Operating with Extra Supply to Inhance Output Voltage Level



Bootstrap Clock Driver Driven from a TTL Gate

*Specifications may change.

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Interface

Advance Information*

DS3643, DS3673 decoded quad MOS clock drivers

general description

The DS3643 and DS3673 are quad bipolar-to-MOS decoder/clock drivers with TTL/DTL compatible inputs. They are designed to provide high output current and voltage capabilities necessary for optimum driving of high capacitance N-channel MOS memory systems.

The device features full decoding of input address lines from two inputs to one of four outputs. Also featured is the capability of expanding to three inputs to one of eight outputs with the use of the Expansion and $\overline{\text{Expansion}}$ inputs. Also included are clock and refresh inputs.

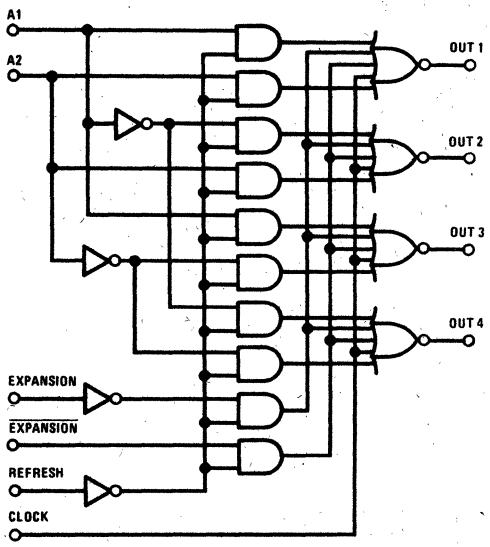
The circuit was designed for driving large capacitive loads at high speeds and uses Schottky-clamped transistors. PNP transistors are used on all inputs, thereby minimizing input loading.

The DS3643 has a 10 Ω damping resistor in series with each output to dampen transients caused by the fast switching output, while the DS3673 has a direct, low impedance output, for use with or without an external resistor.

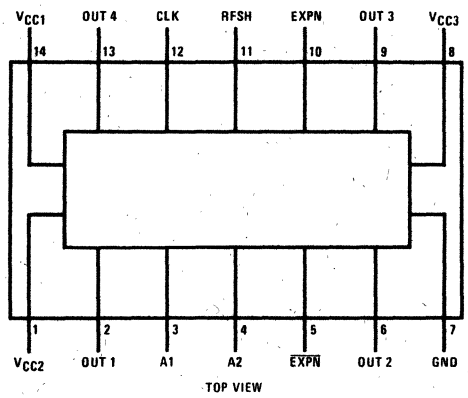
features

- TTL/DTL compatible inputs
- Operates from standard bipolar and MOS supplies
- PNP inputs minimize input loading
- Full logic decoding for either two inputs to one of four outputs or three inputs to one of eight outputs
- High voltage/current outputs
- Input and output clamping diodes
- Control logic optimized for use with MOS memory systems
- Built-in damping resistors (DS3643)

logic and connection diagrams



Dual-In-Line Package



TOP VIEW

Order Number DS3643J or DS3643N

Order Number DS3673J or DS3673N

See Package 9 or 14

truth table

INPUTS						OUTPUTS			
CLOCK	REFRESH	EXPANSION	$\overline{\text{EXPANSION}}$	A_2	A_1	OUT 1	OUT 2	OUT 3	OUT 4
1	X	X	X	X	X	0	0	0	0
0	1	X	X	X	X	1	1	1	1
0	0	1	0	0	0	1	0	0	0
0	0	1	0	0	1	0	1	0	0
0	0	1	0	1	0	0	0	1	0
0	0	1	0	1	1	0	0	0	1
0	0	1	1	X	X	0	0	0	0
0	0	0	1	X	X	0	0	0	0
0	0	0	0	X	X	0	0	0	0

X = Don't Care State.

*Specifications may change.

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DS3644, DS3674 quad TTL to MOS clock drivers general description

The DS3644 and DS3674 are quad bipolar-to-MOS clock drivers with TTL/DTL compatible inputs. They are designed to provide high output current and voltage capabilities necessary for optimum driving of high capacitance N-channel MOS memory systems.

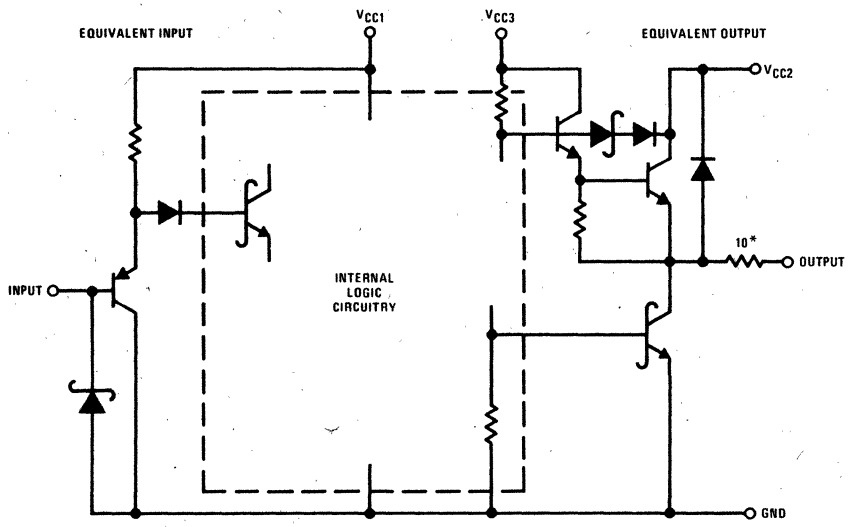
The device features two common enable inputs, a refresh input, and a clock control input for simplified system designs. The circuit was designed for driving highly capacitive loads at high speeds and uses Schottky-clamped transistors. PNP transistors are used on all inputs thereby minimizing input loading.

The DS3644 contains a 10 Ω resistor in series with each output to dampen the transients caused by the fast-switching output, while the DS3674 has a direct, low impedance output for use with or without an external damping resistor.

features

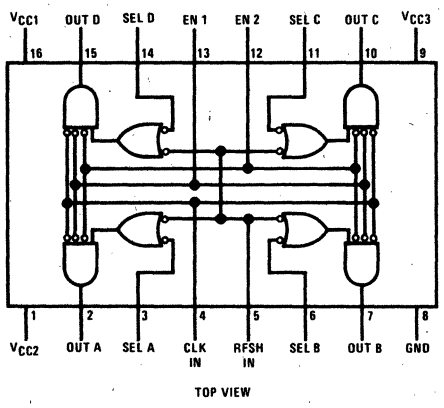
- TTL/DTL compatible inputs
- Operates from standard bipolar and MOS supplies
- PNP inputs minimize loading
- High voltage/current outputs
- Input and output clamping diodes
- Control logic optimized for use with MOS memory systems
- Pin and function compatible with MC3460 and 3235
- Built-in damping resistors (DS3644)

schematic and connection diagrams



*DS3643 only

Dual-In-Line Package



TOP VIEW

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Interface

Advance Information*

DS3651, DS3653 quad high speed MOS sense amplifiers

general description

The DS3651 and DS3653 are TTL compatible high speed circuits intended for sensing in a broad range of MOS memory system applications. Switching speeds have been enhanced over conventional sense amplifiers by application of Schottky technology, and TRI-STATE® strobing is incorporated offering a high impedance output state for bused organization.

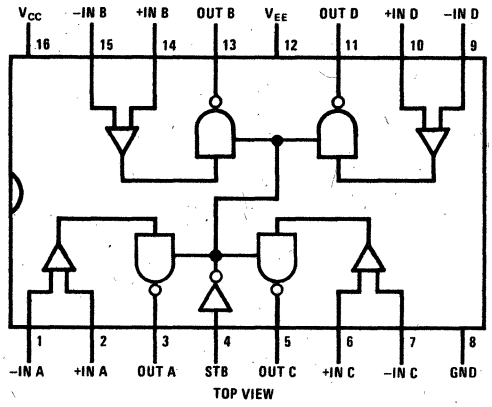
The DS3651 has active pull-up outputs, and the DS3653 offers open collector outputs providing implied "AND" operations.

features

- High speed — 15 ns (typ)
- TTL compatible
- Input sensitivity — ±7 mV
- TRI-STATE outputs for high speed buses
- Standard supply voltages — ±5V
- Pin and function compatible with MC3430 and MC3432

connection diagram

Dual-In-Line Package



TOP VIEW

Order Number DS3651J, DS3653J, DS3651N or DS3653N

See Package 10 or 15

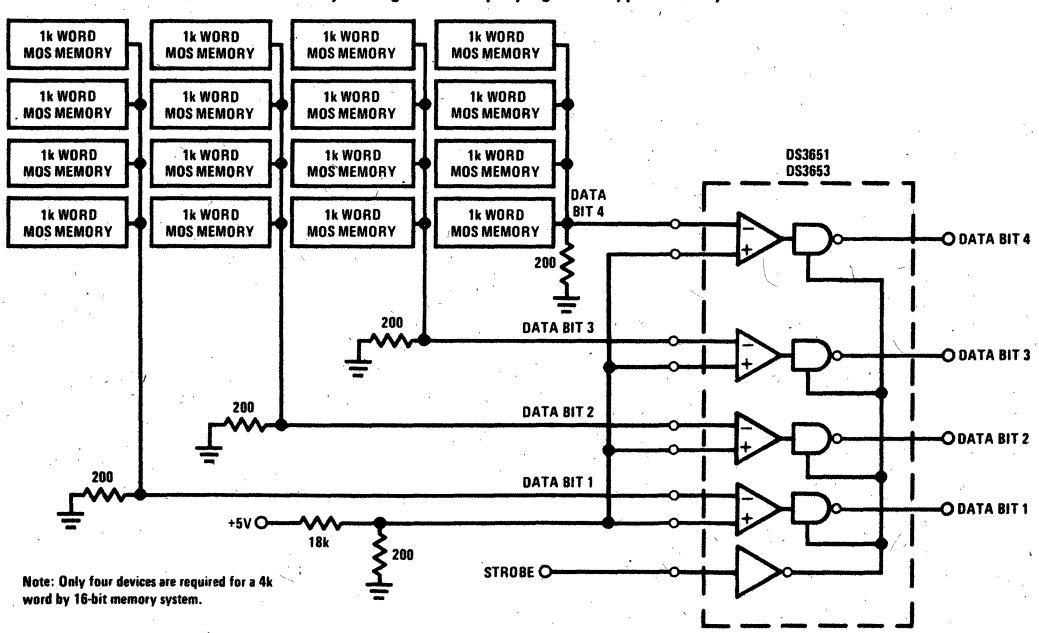
truth table

INPUT	STROBE	OUTPUT	
		DS3651	DS3653
$V_{ID} \geq +7.0$ mV $T_A = 0°C$ to $+70°C$	L H	H Open	Open Open
-7.0 mV $\leq V_{ID} \leq +7.0$ mV $T_A = 0°C$ to $+70°C$	L H	X Open	X Open
$V_{ID} \leq -7.0$ mV $T_A = 0°C$ to $+70°C$	L H	L Open	L Open

L = Low logic state
H = High logic state
Open = TRI-STATE
X = Indeterminate State

typical applications

A Typical MOS Memory Sensing Application for a 4k word by 4-bit memory arrangement employing 1103 type memory devices



Note: Only four devices are required for a 4k word by 16-bit memory system.

*Specifications may change

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Interface

DS7803/DS8803, DS8813 two phase oscillator/clock driver

general description

The DS7803 is a self contained two phase oscillator/clock driver. It requires no external components to generate one of three primary oscillator frequencies and pulse widths. Other frequencies can easily be obtained by programming input voltages. Three sets of outputs are provided: damped and undamped MOS outputs and TTL monitor outputs. The MOS outputs easily drive 500 pF loads with less than 150 ns rise and fall times. In addition the outputs have current limiting to protect against momentary shorts to the supplies.

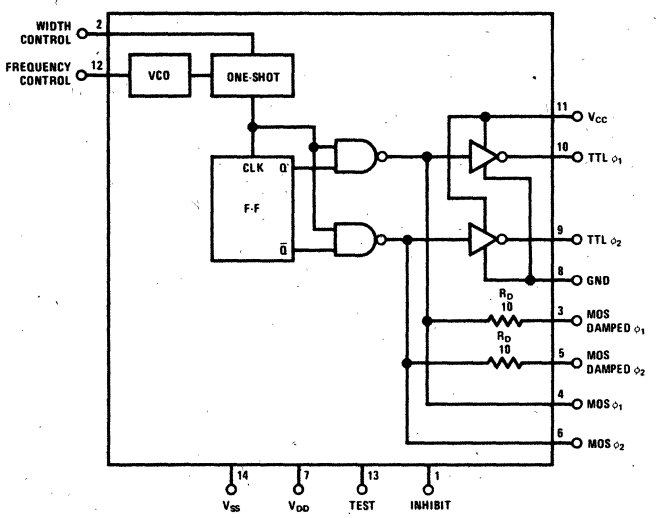
The DS7803 and DS8803 are available in a 14-lead cavity DIP. The DS8803 is also available in a 14-pin molded DIP. The DS8813 comes in an 8-pin molded DIP, providing damped MOS outputs only.

features

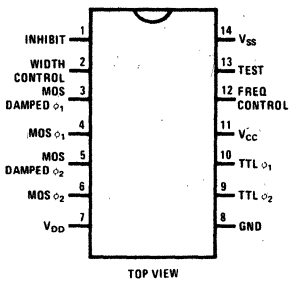
- Two phase non-overlapping outputs
- No external timing components required
- Frequency adjustable from 100 kHz to 500 kHz
- Pulse width adjustable from 260 ns to 1.4μs
- Damped and undamped MOS outputs
- TTL monitor outputs

block and connection diagrams

DS7803/DS8803

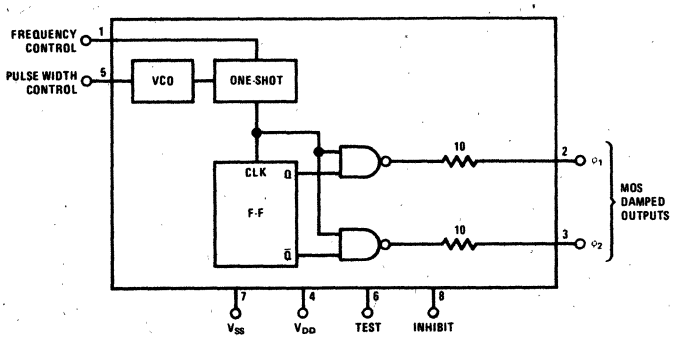


Dual-In-Line Package

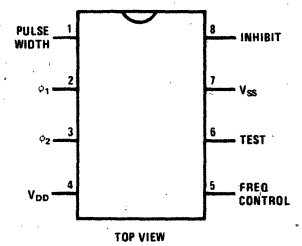


Order Number DS7803J, DS8803J or DS8803N
See Package 9 or 14

DS8813



Dual-In-Line Package



Order Number DS8813N
See Package 12

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DS7807/DS8807, DS8817 two phase oscillator/clock driver

general description

The DS7807 is a self contained two phase oscillator/clock driver. It requires no external components to generate one of three primary oscillator frequencies and pulse widths. Other frequencies can easily be obtained by programming input voltages. Three sets of outputs are provided: damped and un-damped MOS outputs and TTL monitor outputs. The MOS outputs easily drive 500 pF loads with less than 75 ns rise and fall times. In addition the outputs have current limiting to protect against momentary shorts to the supplies.

The DS7807 and DS8807 are available in a 14-lead cavity DIP. The DS8807 is also available in a 14-pin molded DIP.

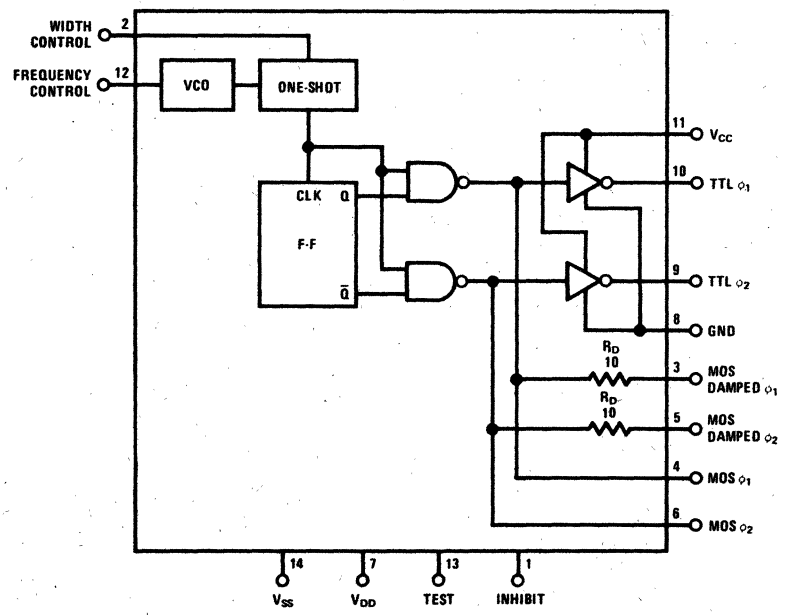
The DS8817 comes in an 8-pin molded DIP, providing damped MOS outputs only.

features

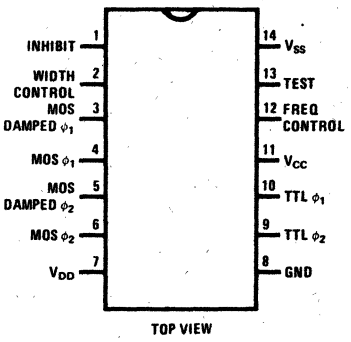
- Two phase non-overlapping outputs
- No external timing components required
- Frequency adjustable from 400 kHz to 2 MHz
- Pulse width adjustable from 130 ns to 700 ns
- Damped and un-damped MOS outputs
- TTL monitor outputs

block and connection diagrams

DS7807/DS8807



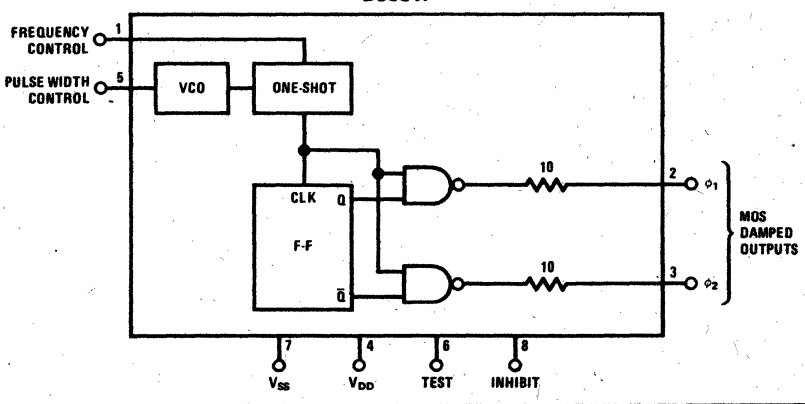
Dual-In-Line Package



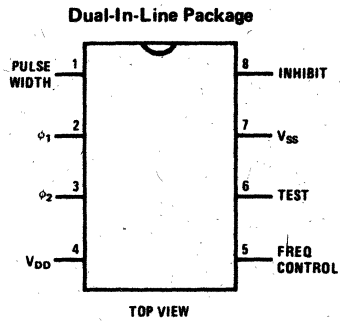
TOP VIEW

Order Number DS7807J, DS8807J or DS8807N
See Package 9 or 14

DS8817



Dual-In-Line Package



TOP VIEW

Order Number DS8817N
See Package 12

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DS16149/DS36149, DS16179/DS36179 hex MOS drivers

general description

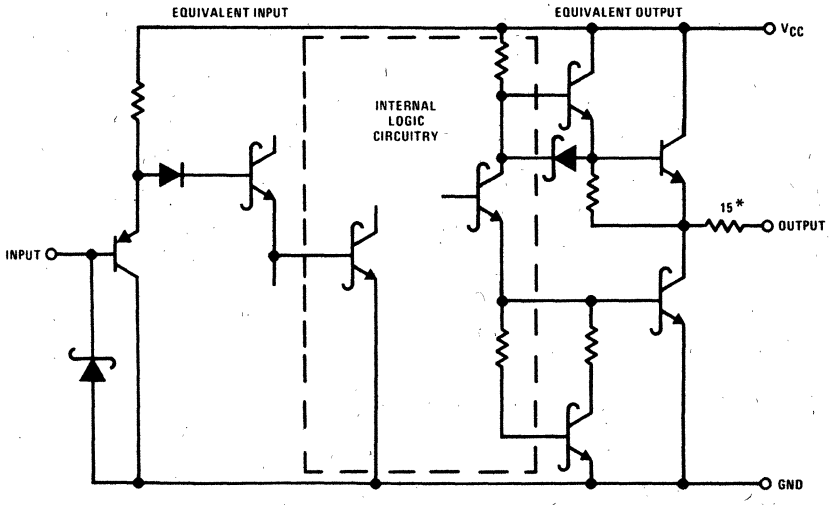
The DS16149/DS36149 and DS16179/DS36179 are Hex MOS drivers with outputs designed to drive large capacitive loads up to 500 pF associated with MOS memory systems. PNP input transistors are employed to reduce input currents allowing the large fan-out to these drivers needed in memory systems. The circuit has Schottky-clamped transistor logic for minimum propagation delay, and a disable control that places the outputs in the logic "1" state (see truth table). This is especially useful in MOS RAM applications where a set of address lines has to be in the logic "1" state during refresh.

The DS1649/DS3649 has a 15 Ω resistor in series with the outputs to dampen transients caused by the fast-switching output. The DS1679/DS3679 has a direct low impedance output for use with or without an external resistor.

features

- High speed capabilities
  - Typ 9 ns driving 50 pF
  - Typ 29 ns driving 500 pF
- TRI-STATE outputs for data bussing
- Built-in 15 Ω damping resistor (DS16149/DS36149)
- Same pin-out as DM8096 and DM74366

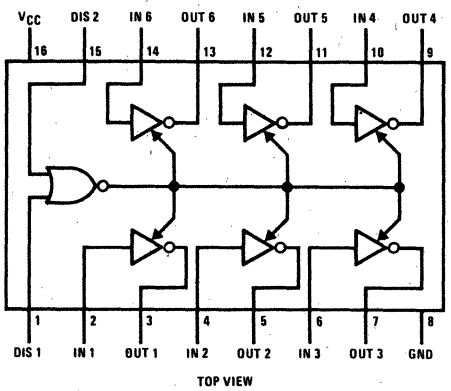
schematic diagram



*DS16149/DS36149 only.

connection diagram

Dual-In-Line Package



TOP VIEW

truth table

DISABLE INPUT		INPUT	OUTPUT
DIS 1	DIS 2		
0	0	0	1
0	0	1	0
0	1	X	1
1	0	X	1
1	1	X	1

X = Don't care

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Product Preview

DS36143, DS36173 decoded quad MOS clock drivers

general description

The DS36143 and DS36173 are quad bipolar-to-MOS decoder/clock drivers with TTL/DTL compatible inputs. They are designed to provide high output current and voltage capabilities necessary for optimum driving of high capacitance N-channel MOS memory systems.

The device features full decoding of input address lines from two inputs to one of four outputs. Also featured is the capability of expanding to three inputs to one of eight outputs with the use of the Expansion and $\overline{\text{Expansion}}$ inputs. Also included are clock and refresh inputs.

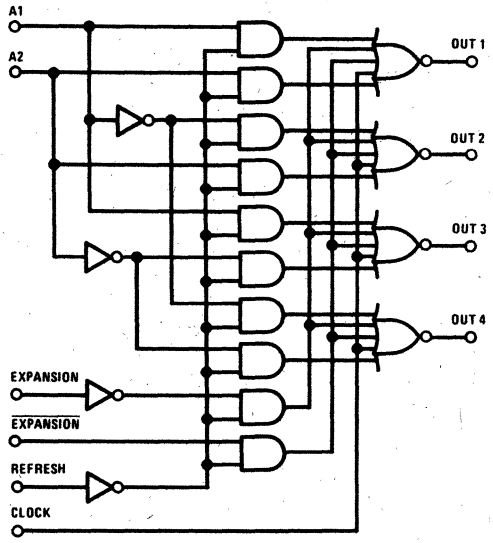
The circuit was designed for driving large capacitive loads at high speeds and uses Schottky-clamped transistors. PNP transistors are used on all inputs, thereby minimizing input loading.

The DS36143 has a 10 Ω damping resistor in series with each output to dampen transients caused by the fast switching output, while the DS36173 has a direct, low impedance output, for use with or without an external resistor.

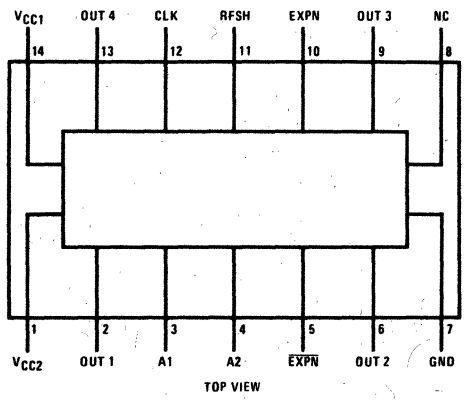
features

- TTL/DTL compatible inputs
- Operates from standard bipolar and MOS supplies
- Two supply operation (5V and 12V)
- PNP inputs minimize input loading
- Full logic decoding for either two inputs to one of four outputs or three inputs to one of eight outputs
- High voltage/current outputs
- Input and output clamping diodes
- Control logic optimized for use with MOS memory systems
- Built-in damping resistors (DS36143)

logic and connection diagrams



Dual-In-Line Package



TOP VIEW

Order Number DS36143J or DS36143N

Order Number DS36173J or DS36173N

truth table

INPUTS						OUTPUTS			
CLOCK	REFRESH	EXPANSION	$\overline{\text{EXPANSION}}$	A_2	A_1	OUT 1	OUT 2	OUT 3	OUT 4
1	X	X	X	X	X	0	0	0	0
0	1	X	X	X	X	1	1	1	1
0	0	1	0	0	0	1	0	0	0
0	0	1	0	0	1	0	1	0	0
0	0	1	0	1	0	0	0	1	0
0	0	1	0	1	1	0	0	0	1
0	0	1	1	X	X	0	0	0	0
0	0	0	1	X	X	0	0	0	0
0	0	0	0	X	X	0	0	0	0

X = don't care state

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Product Preview

DS36144, DS36174 quad TTL to MOS clock drivers

general description

The DS36144 and DS36174 are quad bipolar-to-MOS clock drivers with TTL/DTL compatible inputs. They are designed to provide high output current and voltage capabilities necessary for optimum driving of high capacitance N-channel MOS memory systems.

The device features two common enable inputs, a refresh input, and a clock control input for simplified system designs. The circuit was designed for driving highly capacitive loads at high speeds and uses Schottky-clamped transistors. PNP transistors are used on all inputs thereby minimizing input loading.

The DS36144 contains a 10 Ω resistor in series with each output to dampen the transients caused by the fast-switching output, while the DS36174 has a direct, low impedance output for use with or without an external damping resistor.

features

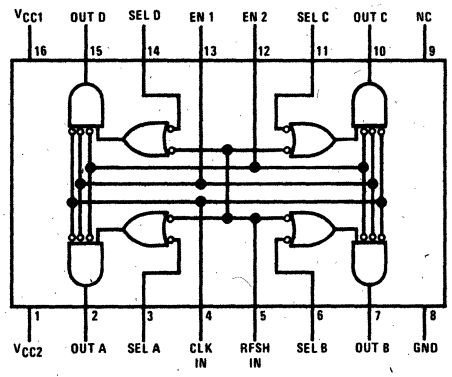
- TTL/DTL compatible inputs
- Operates from standard bipolar and MOS supplies
- Two supply operation (5V and 12V)
- PNP inputs minimize loading
- High voltage/current outputs
- Input and output clamping diodes
- Control logic optimized for use with MOS memory systems
- Pin and function compatible with DS3644, DS3674, MC3460 andMC3235
- Built-in damping resistors (DS36144)

truth table

INPUT					OUTPUT
ENABLE 1	ENABLE 2	SELECT INPUT	CLOCK INPUT	REFRESH INPUT	
1	X	X	X	X	0
X	1	X	X	X	0
X	X	X	1	X	0
X	X	1	X	1	0
0	0	0	0	X	1
0	0	X	0	0	1

connection diagram

Dual-In-Line Package



TOP VIEW

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DS55325/DS75325 memory drivers general description

The DS55325 and DS75325 are monolithic memory drivers which feature high current outputs as well as internal decoding of logic inputs. These circuits are designed for use with magnetic memories.

The circuit contains two 600 mA sink-switch pairs and two 600 mA source-switch pairs. Inputs A and B determine source selection while the source strobe (S_1) allows the selected source turn on. In the same manner, inputs C and D determine sink selection while the sink strobe (S_2) allows the selected sink turn on.

Sink-output collectors feature an internal pull-up resistor in parallel with a clamping diode connected to V_{CC2}. This protects the outputs from voltage surges associated with switching inductive loads.

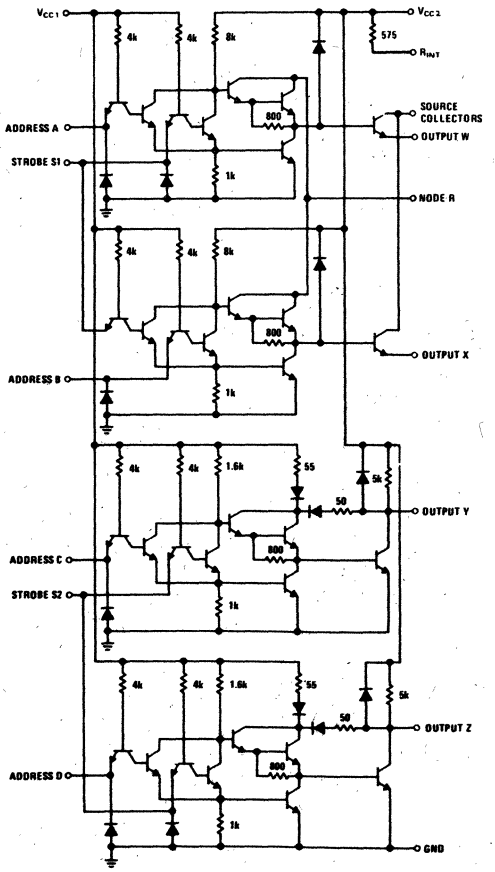
The source stage features Node R which allows extreme flexibility in source current selection by controlling the amount of base drive to each source transistor. This method of setting the base drive brings the power associated with the resistor outside the package thereby allowing the circuit to operate at higher source currents for a given junction temperature. If this method of source current setting is not desired, then Nodes R and R_{INT} can be shorted externally activating an internal resistor connected from V_{CC2} to Node R. This provides adequate base drive for source currents up to 375 mA with V_{CC2} = 15V or 600 mA with V_{CC2} = 24V.

The DS55325 operates over the fully military temperature range of −55°C to +125°C, while the DS5325 operates from 0°C to +70°C.

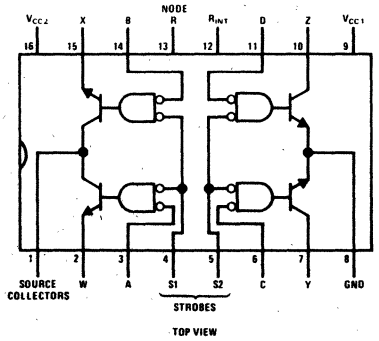
features

- 600 mA output capability
- 24V output capability
- Dual sink and dual source outputs
- Fast switching times
- Source base drive externally adjustable
- Input clamping diodes
- DTL/TTL compatible

schematic and connection diagrams



Dual-In-Line Package



Order Number DS55325J, DS75325J, DS75325N or DS55325W
See Package 10, 15 or 28

truth table

ADDRESS INPUTS				STROBE INPUTS		OUTPUTS			
SOURCE		SINK		SOURCE	SINK	SOURCE		SINK	
A	B	C	D	S1	S2	W	X	Y	Z
L	H	X	X	L	H	ON	OFF	OFF	OFF
H	L	X	X	L	H	OFF	ON	OFF	OFF
X	X	L	H	H	L	OFF	OFF	ON	OFF
X	X	H	L	H	L	OFF	OFF	OFF	ON
X	X	X	X	H	H	OFF	OFF	OFF	OFF
H	H	H	H	X	X	OFF	OFF	OFF	OFF

H = high level, L = low level, X = irrelevant

NOTE: Not more than one output is to be on at any one time.

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DS75322 dual TTL-to-MOS driver

general description

The DS75322 is a monolithic integrated dual TTL-to-MOS driver and interface circuit. The device has separate driver address inputs with common strobe. The device accepts standard TTL and DTL input signals and provides high-current and high-voltage output levels suitable for driving MOS circuits. The DS75322 is designed for driving N-channel RAMs where low power dissipation is desirable when the driver output is in the low state. It may be used to drive the chip-enable clock of 4096-bit dynamic MOS RAM components.

The DS75322 requires two external PNP transistors per package.

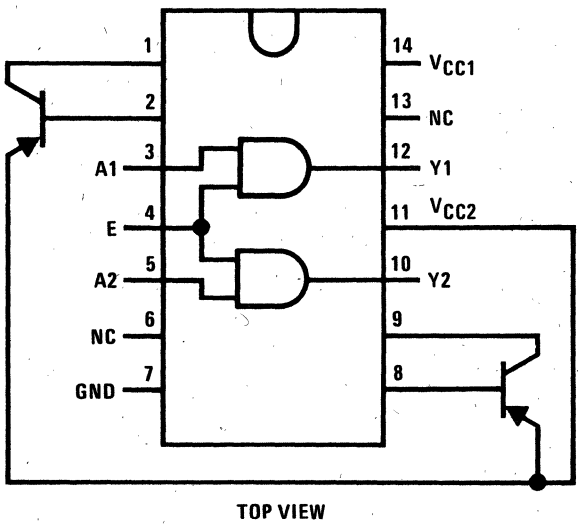
The DS75322 operates from the TTL 5V supply and the MOS V_{DD} supply. With the use of an external pull-down resistor, the driver output of the DS75322 will be forced to the low state upon loss of the 5V supply.

features

- Operates from standard bipolar and MOS supply voltages
- High speed switching
- TTL and DTL compatible inputs
- Separate driver address inputs with common strobe
- V_{OH} and V_{OL} compatible with 4k RAMs
- No 12V supply current (except leakage) when output in low state
- Low 5V supply supply current when output in low state
- Output in high impedance state upon loss of 5V supply
- Requires 2 external PNPs per package for operation

connection diagram

Dual-In-Line Package



TOP VIEW

Positive logic: $Y = AE$

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Interface

DS75324 memory driver with decode inputs

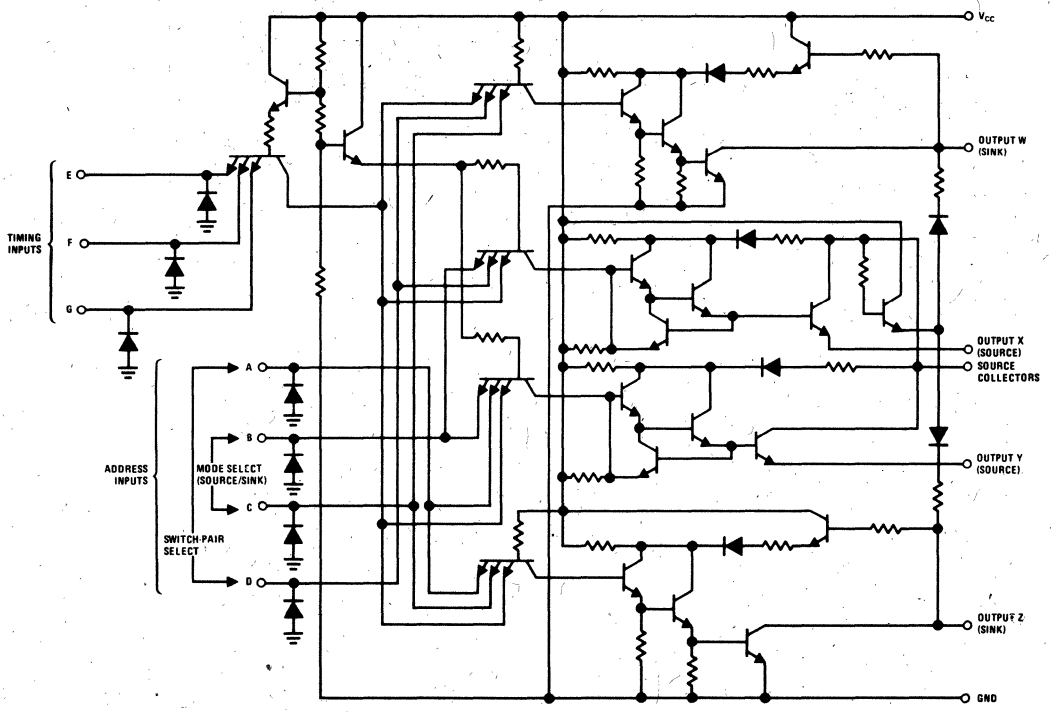
general description

The DS75324 is a monolithic memory driver which features two 400 mA (source/sink) switch pairs along with decoding capability from four address lines. Inputs B and C function as mode selection lines (source or sink) while lines A and D are used for switch-pair selection (output pair Y/Z or W/X).

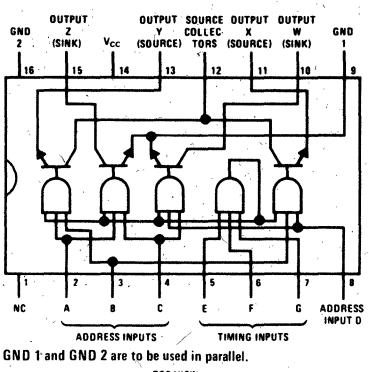
features

- High voltage outputs
- Dual sink/source outputs
- Internal decoding and timing circuitry
- 400 mA output capability
- DTL/TTL compatible
- Input clamping diodes

schematic and connection diagrams



Dual-In-Line Package

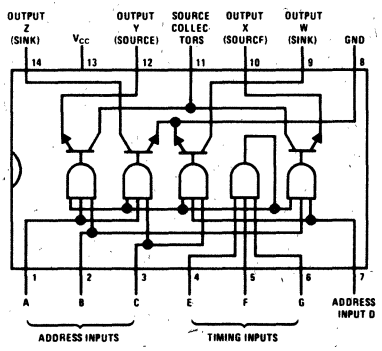


GND 1 and GND 2 are to be used in parallel.

TOP VIEW

Order Number DS75324J
See Package 10

Dual-In-Line Package



TOP VIEW

Order Number DS75324N
See Package 14

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DS75361 dual TTL-to-MOS driver

general description

The DS75361 is a monolithic integrated dual TTL-to-MOS driver interface circuit. The device accepts standard TTL and DTL input signals and provides high-current and high-voltage output levels for driving MOS circuits. It is used to drive address, control, and timing inputs for several types of MOS RAMs including the 1103 and MM5270 and MM5280

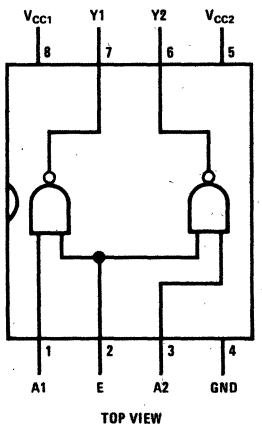
The DS75361 operates from standard TTL 5V supplies and the MOS V_{SS} supply in many applications. The device has been optimized for operation with V_{CC2} supply voltage from 16V to 20V; however, it is designed for use over a much wider range of V_{CC2}.

features

- Capable of driving high-capacitance loads
- Compatible with many popular MOS RAMs
- V_{CC2} supply voltage variable over wide range to 24V
- Diode-clamped inputs
- TTL and DTL compatible
- Operates from standard bipolar and MOS supplies
- High-speed switching
- Transient overdrive minimizes power dissipation
- Low standby power dissipation

connection diagrams

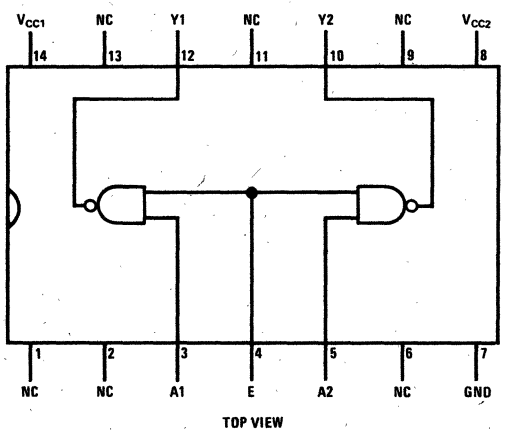
Dual-In-Line Package



TOP VIEW

Order Number DS75361N
See Package 12

Dual-In-Line Package



TOP VIEW

Order Number DS75361J
See Package 9

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DS75362 dual TTL-to-MOS driver

general description

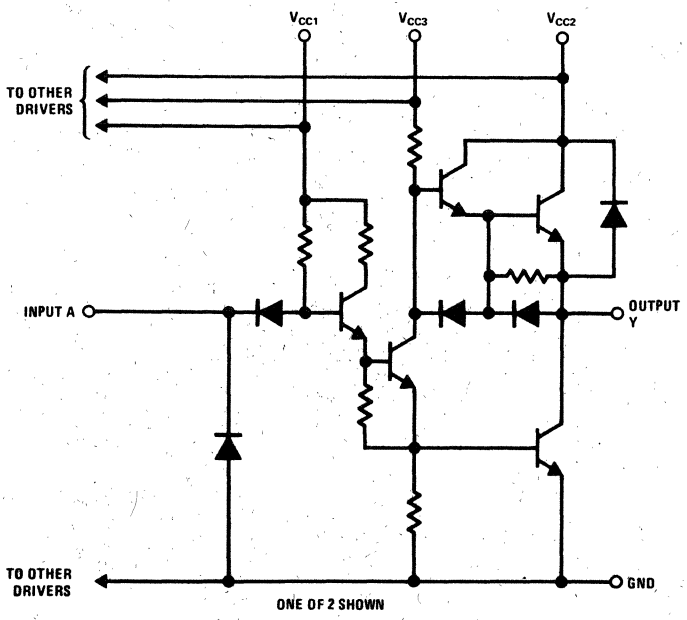
The DS75362 is a dual monolithic integrated TTL-to-MOS driver and interface circuit that accepts standard TTL and DTL input signals and provides high-current and high-voltage output levels suitable for driving MOS circuits. It is used to drive address, control, and timing inputs for several types of MOS RAMs including the 1103.

The DS75362 operates from the TTL 5V supply and the MOS V_{SS} and V_{BB} supplies in many applications. This device has been optimized for operation with V_{CC2} supply voltage from 16V to 20V, and with nominal V_{CC3} supply voltage from 3V to 4V higher than V_{CC2}. However, it is designed so as to be usable over a much wider range of V_{CC2} and V_{CC3}. In some applications the V_{CC3} power supply can be eliminated by connecting the V_{CC3} pin to the V_{CC2} pin.

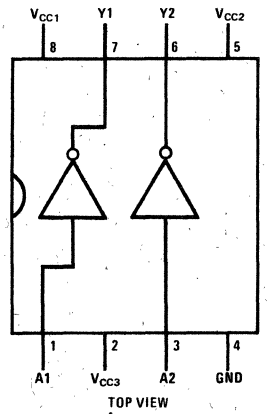
features

- Dual positive-logic NAND TTL-to-MOS driver
- Versatile interface circuit for use between TTL and high-current, high-voltage systems
- Capable of driving high-capacitance loads
- Compatible with many popular MOS RAMs
- V_{CC2} supply voltage variable over wide range to 24V maximum
- V_{CC3} supply voltage pin available
- V_{CC3} pin can be connected to V_{CC2} pin in some applications
- TTL and DTL compatible diode-clamped inputs
- Operates from standard bipolar and MOS supply voltages
- High-speed switching
- Transient overdrive minimizes power dissipation
- Low standby power dissipation

schematic and connection diagrams

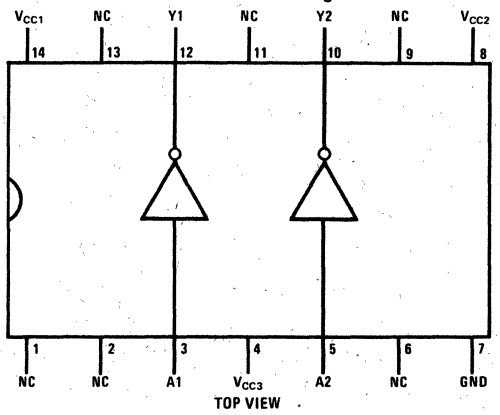


Dual-In-Line Package



Order Number DS75362N
See Package 12

Dual-In-Line Package



Order Number DS75362J
See Package 9

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DS75364 dual MOS clock driver

general description

The DS75364 is a dual MOS driver and interface circuit that operates with either current source or voltage source input signals. The device accepts signals from TTL levels or other logic systems and provides high current and high voltage output levels suitable for driving MOS circuits. It may be used to drive address, control and/or timing inputs for several types of MOS RAMs and MOS shift registers.

The DS75364 operates from standard MOS and bipolar supplies, and has been optimized for operation with V_{CC1} supply voltage from 12–20V positive with respect to V_{EE}, and with nominal V_{CC2} supply voltage from 3–4V more positive than V_{CC1}. However, it is designed so as to be useable over a much wider range of V_{CC1} and V_{CC2}. In some applications the V_{CC2} power supply can be eliminated by connecting the V_{CC2} pin to the V_{CC1} pin.

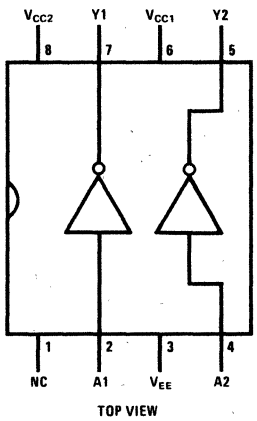
Inputs of the DS75364 are referenced to the V_{EE} terminal and contain a series current limiting resistor. The device will operate with either positive input current signals or input voltage signals which are positive with respect to V_{EE}. In many applications the V_{EE} terminal is connected to the MOS V_{DD} supply of −12V to −15V with the inputs to be driven from TTL levels or other positive voltage levels. The required negative level shifting may be done with an external PNP transistor current source or by use of capacitive coupling and appropriate input voltage pulse characteristics.
The DS75364 is characterized for operation over the 0°C to +70°C temperature range.

features

- Versatile interface circuit for use between TTL levels and level shifted high current, high voltage systems
- Inputs may be level shifted by use of a current source or capacitive coupling or driven directly by a voltage source
- Capable of driving high capacitance loads
- Compatible with many popular MOS RAMs and MOS shift registers
- V_{CC1} supply voltage variable over wide range to 22V maximum with respect to V_{EE}
- V_{CC2} pull-up supply voltage pin available
- Operates from standard bipolar and/or MOS supply voltages
- High-speed switching
- Transient overdrive minimizes power dissipation
- Low standby power dissipation

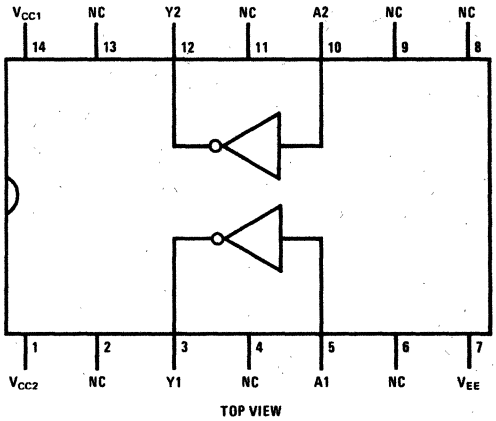
connection diagrams

Dual-In-Line Package



Order Number DS75364N
See Package 12

Dual-In-Line Package



Order Number DS75364J
See Package 9

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DS75365 quad TTL-to-MOS driver

general description

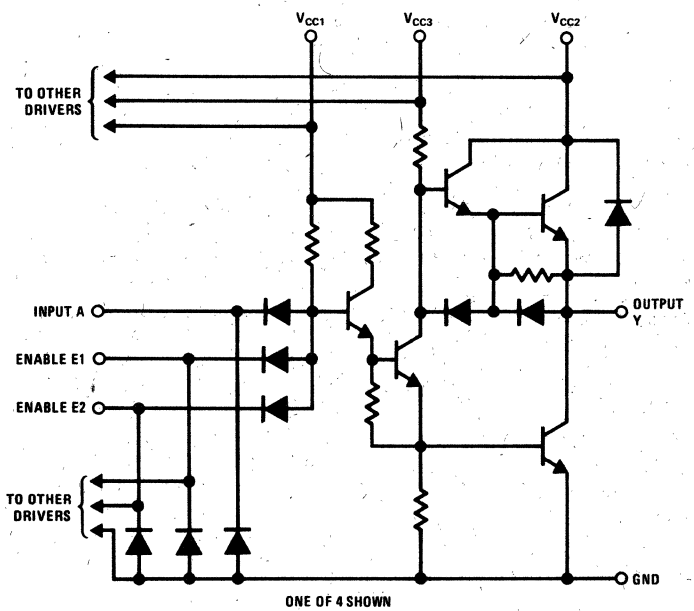
The DS75365 is a quad monolithic integrated TTL-to-MOS driver and interface circuit that accepts standard TTL and DTL input signals and provides high-current and high-voltage output levels suitable for driving MOS circuits. It is used to drive address, control, and timing inputs for several types of MOS RAMs including the 1103.

The DS75365 operates from the TTL 5V supply and the MOS V_{SS} and V_{BB} supplies in many applications. This device has been optimized for operation with V_{CC2} supply voltage from 16V to 20V, and with nominal V_{CC3} supply voltage from 3V to 4V higher than V_{CC2}. However, it is designed so as to be usable over a much wider range of V_{CC2} and V_{CC3}. In some applications the V_{CC3} power supply can be eliminated by connecting the V_{CC3} pin to the V_{CC2} pin.

features

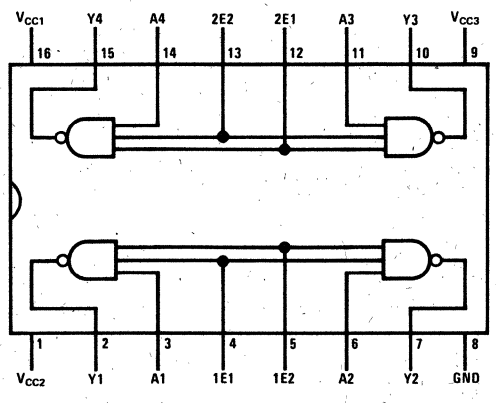
- Quad positive-logic NAND TTL-to-MOS driver
- Versatile interface circuit for use between TTL and high-current, high-voltage systems
- Capable of driving high-capacitance loads
- Compatible with many popular MOS RAMs
- Interchangeable with Intel 3207
- V_{CC2} supply voltage variable over wide range to 24V maximum
- V_{CC3} supply voltage pin available
- V_{CC3} pin can be connected to V_{CC2} pin in some applications
- TTL and DTL compatible diode-clamped inputs
- Operates from standard bipolar and MOS supply voltages
- Two common enable inputs per gate-pair
- High-speed switching
- Transient overdrive minimizes power dissipation
- Low standby power dissipation

schematic and connection diagrams



ONE OF 4 SHOWN

Dual-In-Line Package



TOP VIEW

Positive Logic: $Y = \overline{A \cdot E1 \cdot E2}$

Order Number DS75365J
or DS75365N
See Package 10 or 15

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3½ DIGIT A/D CONVERTER SET

LD110 DIGITAL A/D PROCESSOR
LD111 ANALOG A/D PROCESSOR
LD114 DIGITAL A/D PROCESSOR

Features

- 0.05% Accuracy (Of Reading) ±1 Count
- Two Voltage Ranges—1.999 V and 199.9 mV
- Sampling Rates up to 12 Samples/Second
- FET Input for $Z_{in} > 1000$ MΩ
- Auto-Zero Minimizes Effects of Offset, Drift and Temperature
- Auto-Polarity
- Monolithic Bipolar—PMOS Analog Circuit
- PMOS Digital Circuit
- Multiplexed BCD Output
- Overrange and Underrange Signals Available for Auto-Ranging Capability
- TTL Compatible Outputs

Applications

- DVM/DPM
- A/D Converters
- Controllers
- Digital Weighing Systems
- Digital Thermometers
- Process Control Instrumentation
- Scientific Instrumentation

Description

The monolithic LD111 analog processor contains a bipolar comparator, a bipolar integrating amplifier, two MOS-FET input unity gain amplifiers, several P-channel enhancement mode analog switches and the necessary level shifting drivers to allow the analog and digital processors to be directly interfaced. A wide range of conversion rates (1/3 to 12 samples per second) as well as two voltage ranges can be accommodated using externally determined RC time constants. All amplifiers are internally compensated.

The PMOS LD110 synchronous digital processor combines the counting, storage and data multiplexing functions with the random logic necessary to control the quantized charge-balancing function of the analog processor. Seventeen static latches store the 3½ digits of BCD data as well as overrange, underrange and polarity information. Nine push-pull output buffers (capable of driving one standard TTL load each) provide the sign, digit strobe and multiplexed BCD data outputs, all of which are active high. The digit scan is an interlaced format of digits 1, 3, 2 and 4.

The PMOS LD114 digital processor combines the counting storage and data multiplexing functions with the random logic necessary to control the quantized charge-balancing function of the analog processor. Seventeen static latches, in response to external control, store the 3 1/2 Digits of BCD data as well as underrange and polarity information. Ten push-pull output buffers (capable of driving one standard TTL load) provide the clock frequency ÷ 512, sign, digit strobe and multiplexed BCD data. Four data output format options allow the user to tailor the BCD output to his circuit requirements. Please see the following pages for greater detail.

MONOLITHIC CMOS A/D CONVERTERS

LD130 3 DIGIT A/D CONVERTER
LD131 3⅓ DIGIT A/D CONVERTER

Features

- Accuracy of 0.1% (of reading) ±1 Count
- Auto-Zero
- Auto-Polarity
- Low Power Consumption (25 mW Typical)
- 1 mV Resolution (LD130 - 1.000 V, LD131 - 1.500 V, Full Scale)
- Minimum of External Components (3 Capacitors, 1 Reference)
- Buffered Analog Input ($Z_{IN} > 1000$M Ω)
- Buffered Reference Input ($Z_{IN} > 1000$M Ω)
- Internal Clock Oscillator
- Overrange and Underrange Signals Provided for Auto-ranging
- Multiplexed BCD with Inter-Digit Blanking
- TTL Compatible Outputs (1 Load)
- Sampling Rates from 1 to 60 samples/second

Applications

- DVM/DPM
- Digital Thermometers
- Digital Environment Meters (Noise, Light, pH)
- Digital Scales
- Instrumentation
- Controllers
- μP Interface to Analog World

Description

The LD130 and LD131 combine, in a single monolithic CMOS I.C., both the analog and digital subsystems of a 3 digit and a 3⅓ digit A/D system, respectively. The "Quantized Feedback" conversion scheme, introduced by Siliconix, provides the LD130 and LD131 with an Auto-zero, Auto-polarity A/D system requiring only a single reference voltage. External parts are minimized by the on-chip resistors and buffer amplifiers. These high impedance input and reference buffer amplifiers eliminate source loading errors providing the outstanding temperature coefficient and ratio operation inherent in this system. Break-before-make switch action insures that neither the analog input nor the reference voltage will be shorted to ground at any time. Please see the following pages for greater detail.

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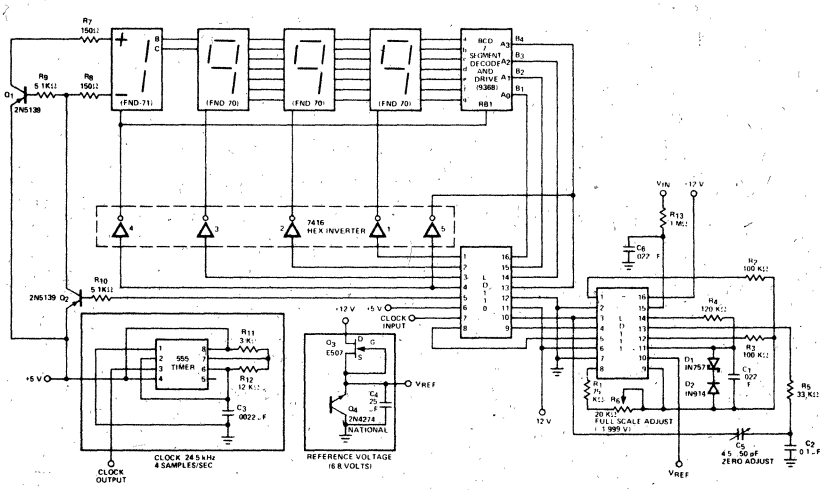
LD110/LD111/LD114 3½ DIGIT A/D CONVERTER SET

ELECTRICAL CHARACTERISTICS

All DC parameters are 100% tested at 25°C. Lots are sample-tested for AC parameters and high and low temperature limits to assure conformance with specifications.

		CHARACTERISTIC		MIN	TYP	MAX	UNIT	TEST CONDITIONS, UNLESS NOTED: V_1 = 12 V, V_2 = −12 V, V_{SS} = 5 V, V_{REF} = 8.2 V, T_A = 25°C
1	INPUT	f_{IN}	Clock Frequency		30.7		KHz	50% Duty Cycle
2		I_{CL}	Clock Input Current, Low			−500	μA	V_{CLOCK} in = 0.4 V
3		I_{IN}	Input Bias Current		4		pA	T_A = 25°C
4					40			T_A = 70°C
5		NMR	Normal Mode Rejection		40		dB	f_L = 60 Hz
6	OUTPUT	V_{OL1}	Measure/Zero Voltage, Low			0.4	V	I_{OL} = 150 μA
7		V_{OH1}	Measure/Zero Voltage, High	2.4				I_{OH} = −200 μA
8		V_{OL2}	Up/Down Logic Voltage, Low			0.4		I_{OL} = 250 μA
9		V_{OH2}	Up/Down Logic Voltage, High	2.4				I_{OH} = −200 μA
10		V_{OH3}	Analog Comparator Voltage	2.4				I_{OH} = −100 μA
11		V_{OL3}	Digits, Bits, Sign Voltage			0.4		I_{OL} = 1.6 mA
12		V_{OH4}	Data Bits Voltage, High	2.4				I_{OH} = −200 μA
13		V_{OH5}	Digits, Sign Voltage, High	2.4				I_{OH} = −800 μA
14	SWITCH	$r_{DS(on)}$	ON Resistance, Auto Zero Switch		11	50	KΩ	$V_{AZ(in)}$ = −4.0 V, I_S = −50 μA
15		$r_{DS(on)}$	ON Resistance, Up/Down Switch		650	3000	Ω	I_S = 1 mA
16		TC	Up/Down Switch Temperature Coefficient		0.20	0.50	%/°C	
17	SUPPLY	I_1	Supply Current		2.2	3.5	mA	
18		I_{2A}	Supply Current, LD111		−1.8	−3.0		
19		I_{2D}	Supply Current, LD110		−17	−23		
20		I_{SS}	Supply Current		17.4	24		
21		$PSRR_1$	Power Supply Rejection Ratio, V_1	80	85		dB	
22		$PSRR_2$	Power Supply Rejection Ratio, V_2	60	65			
23		Reference Current Rejection Ratio		35	41		nA/LSB	R_{REF} = R_2 = 100K Ω, V_{IN} = 2 V

Typical values are for DESIGN AID ONLY, not guaranteed and not subject to production testing. **LD110 IPAN LD111 CMAF**



3½ Digit DVM (±2.000 Volts)

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LD130/LD131 MONOLITHIC A/D CONVERTERS

ELECTRICAL CHARACTERISTICS

All DC parameters are 100% tested at 25°C. Lots are sample tested for AC parameters to assure conformance with specifications.

		CHARACTERISTIC		MIN	TYP	MAX	UNIT	TEST CONDITIONS V_1 = +5 V, V_2 = −5 V, V_{REF} = 2.000 V T_A = 25°C, C_{INT} = 0.068 µF, C_{strg} = 0.1 µF
1	GENERAL		Linearity			0.1	% rdg	
2	GENERAL		Noise		0.3		LSB	Peak-to-Peak noise apparent when going from one steady reading to another.
3	GENERAL		Zero T. C.		10		µV/°C	$0 \leq T_A \leq 70°C$
4	GENERAL		Gain T. C.		15		ppM/°C	$0 \leq T_A \leq 70°C$
5	GENERAL		NMR Normal Mode Rejection	36			dB	f_{series} = 60 Hz, f_{osc} = 24 kHz
6	INPUT	I_{IN}	V_{IN} Input Bias Current		7		pA	T_A = 25°C
7	INPUT	I_{IN}	V_{IN} Input Bias Current		90		pA	T_A = 70°C
8	INPUT	I_{REF}	V_{REF} Input Bias Current		7		pA	T_A = 25°C
9	INPUT	I_{REF}	V_{REF} Input Bias Current		90		pA	T_A = 70°C
10	INPUT	f_{CLK}	Clock Frequency		30		kHz	
11	INPUT	D.C.$_{CLK}$	Clock Duty Cycle	30/70		70/30	%	
12	INPUT	I_{INL}	Clock Input Current Low			1	mA	V_{INL} = 0.25 V
13	INPUT	I_{INH}	Clock Input Current High			1	mA	V_{INH} = 4.75 V
14	OUT	V_{OL}	All Outputs			0.4	V	I_{OL} = 1.6 mA
15	OUT	V_{OH}	Digit Strobes	2.4			V	I_{OH} = −400 µA
16	OUT	V_{OH}	Data Bits, SIGN/UR/OF	2.4			V	I_{OH} = −100 µA
17	SUPPLY	I_1	Supply Current			6	mA	
18	SUPPLY	I_2	Supply Current			4	mA	
19	SUPPLY	$PSRR_1$	V_1 Supply Rejection		0.6		mV/V	
20	SUPPLY	$PSRR_2$	V_2 Supply Rejection		1.4		mV/V	

Typical values are for Design Aid Only, not guaranteed and not subject to production testing. **ICBG**

APPLICATIONS

1. **Operation Over the Full Frequency Range.** Any sampling rate from 1 to 60 samples per second can be accommodated by simply changing the Integrator and Oscillator Capacitors (C_{INT} and C_{osc}). The Auto-Zero Capacitor (C_{AZ}) should remain at 0.1 µF over the full sampling range.
   a. To find the proper value for C_{osc}, refer to the clock frequency vs C_{osc} curve shown in the Typical Characteristics. The oscillator frequency and sampling rates are related by:

   $$\text{Sampling Rate} = \frac{f_{osc}}{6144}$$

   b. The integrator capacitor must change as a function of frequency by means of the following relationship:

   $$C_{INT} \cong \frac{2000}{f_{osc}} \ \mu F/sec$$

   Capacitor tolerance or type is not critical. C_{AZ} and C_{INT} should have a high insulation resistance over temperature (all film capacitors are suitable).
2. **Supply Voltages.** Minimum supply voltages for operation are V_1 = +5 V, V_2 = −5 V. Maximum voltages for functionality are V_1 = +8 V, V_2 = −8 V. It is recommended that a 0.1 µF or larger capacitor be used to bypass V_1 to ground at the LD131 when LED displays are used.
3. **Reference Voltage.** The typical LD131 application (Figure 5) shows the reference voltage being developed by a current regulator diode-resistor combination. This is the preferred method for creating stable low-voltage references. The temperature compensated current regulator diode (the electrical dual of the temperature compensated Zener) keeps a constant current through the series connection of metal film resistor and cermet trimmer. A typical temperature coefficient of 50 ppM/°C is achieved by this system — an order of magnitude improvement over a typical low-voltage Zener (1N746, 3.3 V Zener).

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LD130/LD131 MONOLITHIC A/D CONVERTERS

4. **Input Protection.** The LD130 has protection circuitry at all inputs and outputs which prevent static damage by clamping the voltage at these pins. In many applications, such as a DMM/DVM, the V_{IN} or V_{REF} input may have a high voltage source connected which is capable of supplying destructive currents into the LD130. To prevent such an occurrence, a current limiting resistor should be placed in series with the appropriate input pin. The 1 mA maximum current rating should be observed. A 1M Ω resistor in series with pin 17 of the LD130 would offer input protection up to a 1000 V overvoltage.

5. **Lock-Up Protection.** The E204 J-FET shown in the typical LD130 application of Figure 1 eliminates a power-on lock-up mode. This condition manifests itself by a constant 007 output. If the J-FET is not used, it may be necessary to recycle the power supplies to attain normal operation. The use of the E204 J-FET reduces the maximum allowable negative supply voltage, V_2 to −5.5 V.

6. **TTL Compatibility.** While both the Digit Strobe (D_1, D_2, D_3) and Data Bit (B_0, B_1, B_2, B_3) outputs are capable of driving 1 TTL load, the maximum internal clock stability, and thus A/D stability, is attained when the bit outputs sink less than 400 μA. Therefore, CMOS or low-power Schottky TTL decoders are preferred. Standard TTL loads will not contribute to A/D instability when an external oscillator is used.

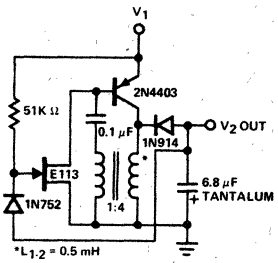
7. **DC to DC Converter.** The low power requirement of the LD130 makes it well suited for battery powered applications. The converter circuit shown in Figure 2 is an efficient means of providing the −5 V supply from a 4 to 8 V V_1 supply.

8. **Range Signal Decoding — Autoranging.** The ranging signals (overrange and underrange) are time multiplexed on the SIGN/UR/OR output. De-multiplexing consists of logically ANDING this output with either the D_1 or D_2 Digit Strobe output Thus:

D_1 · SIGN/UR/OR = Underrange Pulse (active high) when count < 80

D_2 · SIGN/UR/OR = Overrange Pulse (active high) when count > 999

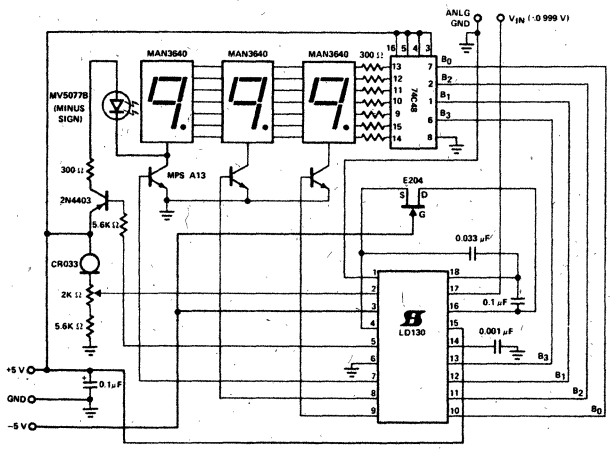
If either an underrange or overrange condition exists, the appropriate pulse will occur once each sampling interval during the zeroing time. This single pulse can be used directly to step on Autoranging circuit into the next range. Figure 3 shows the implementation of an Autoranging System for the LD130.



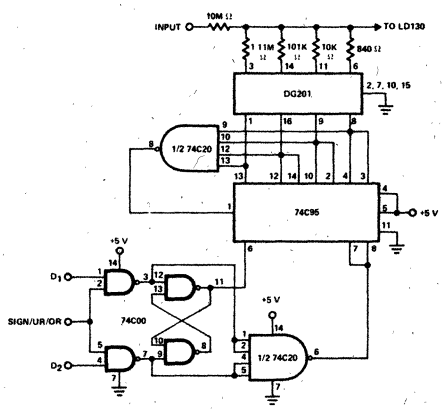
DC to DC Converter
Figure 2

9. **Ratio Operation.** The high impedance reference buffer amplifier and input buffer amplifier make the LD130 very useful in ratio measurements. The ratio error curve is shown in the Typical Characteristics. The ratio of the internal scaling resistors makes the output a simple relationship of V_{IN} and V_{REF}.

$$COUNT = \frac{V_{IN}}{V_{REF}} \times 2000$$



3 Digit DVM (±999 mV, 5 samples/sec)
Figure 1



Autoranging System For LD130
Figure 3

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HIGH SPEED, POWER PERIPHERAL DRIVERS (to 1.0 A, 90 V)

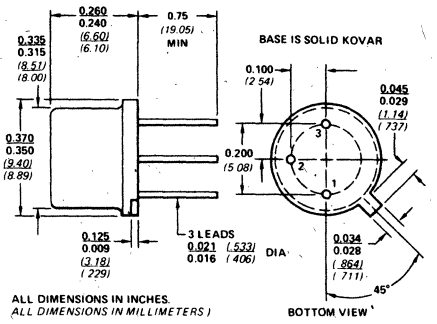
S55V01 SERIES
S75V01 SERIES

Features

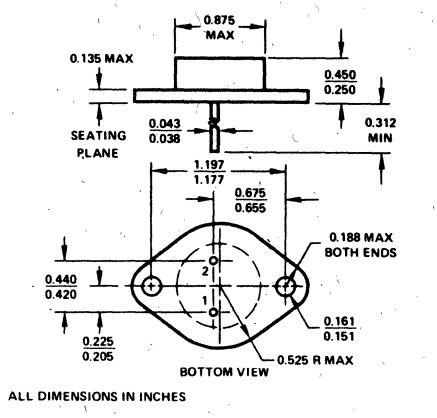
- CMOS Compatible Input
- 4 ns to 10 ns Propagation Delay Time
- High Input Impedance (megohms)
- Fan Out Greater Than 100
- Parallel Easily
- Free from Secondary Breakdown
- 90 V Breakdown Voltages
- 1.0 A Output Currents

Absolute Maximum Ratings

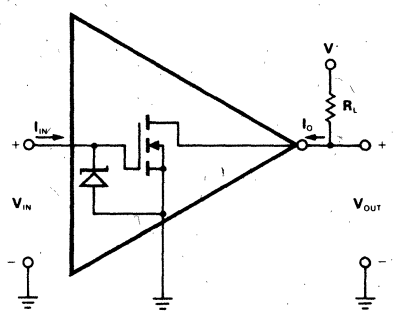
Output Current	
S55V01, 11, 12/S75V01,11,12	2.0 A
S55V02, 21, 22/S75V02, 21, 22	1.5 A
Output Voltage	
S55V01, 02/S75V01, 02	60 V
S55V11, 21/S75V11, 21	35 V
S55V12, 22/S75V12, 22	90 V
Input Voltage	15 V
Storage Temperature Range	−55°C to + 150°C
Operating Temperature Range	
S55V01, 02, 11, 21, 12, 22	−55°C to + 150°C
S75V01, 02, 11, 21, 12, 22	0°C to + 70°C
P_D at 25°C Case Temperature	
S55V01, 11, 12/S75V01, 11, 12	25 W
S55V02, 21, 22/S75V02, 21, 22	4 W
Thermal Derating Factor	
S55V01, 11, 12/S75V01, 11, 12	5° C/W
S55V02, 21, 22/S75V02, 21, 22	30° C/W
Lead Soldering Temperature (10 s)	260° C



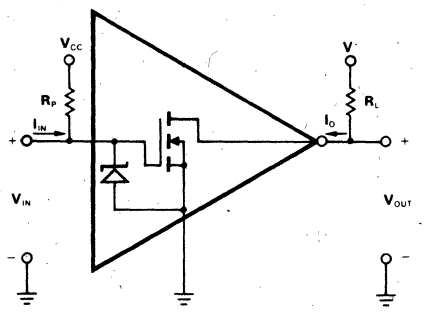
TO-39



TO-3



Simplified Schematic
Fig. 1



For TTL Inputs
Fig. 2

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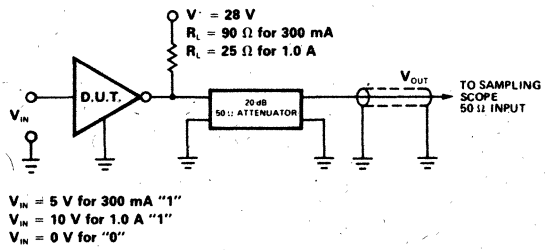
HIGH SPEED, POWER PERIPHERAL DRIVERS (to 1.0 A, 90 V)

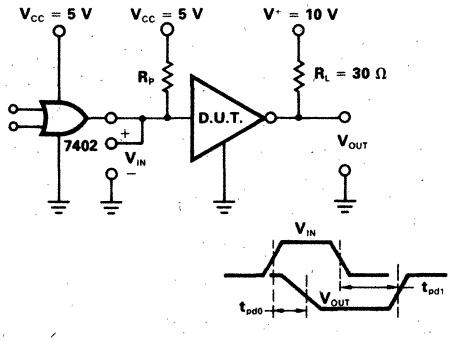
S55V01 SERIES S75V01 SERIES

ELECTRICAL CHARACTERISTICS (25°C Unless Otherwise Noted)

PARAMETER	CONDITIONS	S55V11, 21 S75V11, 21			S55V01, 02 S75V01, 02			S55V12, 22 S75V12, 22			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IH} Logical "1" Input Voltage	I_O = 100 mA	4.0	2.0		4.0	2.0		4.0	2.0		V
	I_O = 300 mA	5.0	3.5		5.0	3.5		5.0	3.5		
	I_O = 1,000 mA	10.0	6.5		10.0	6.5		10.0	6.5		
V_{IL} Logical "0" Input Voltage	I_O = 1.0 mA		1.2	0.8		1.2	0.8		1.2	0.8	V
	I_O = 0.1 mA		0.8			0.8			0.8		
	I_O = 0.5 μA			0			0			0	
I_{IH} Logical "1" Input Current	V_{IN} = 15 V, V_{OUT} = 0		0.01	0.5		0.01	0.5		0.01	0.5	μA
V_{OH} Output Breakdown Voltage	I_O = 100 μA, V_{IN} = 0	35			60			90			V
SPECIFICATIONS FOR USE WITH CMOS (FIGS. 1 & 3)											
I_{IL} Logical "0" Input Current	V_{IN} = OV, V_{OUT} = V_{OH}		-0.01			-0.01			-0.01		μA
V_{OL} Output "ON" Voltage	I_O = 100 mA V_{IN} = 5V		0.2	0.25		0.3	0.35		0.37	0.45	V
	I_O = 300 mA V_{IN} = 5V		0.72	0.9		1.0	1.2		1.4	1.7	
	I_O = 1,000 mA V_{IN} = 10 V		1.4	2.0		2.2	3.0		3.8	4.5	
t_{pd0} Propagation Delay to Logical "0" (Output Turn "ON")	$I_O \approx$ 1.0 A, V_{IN} = 0→ 10V, Fig. 3		4.0	10		4.0	10		4.0	10	ns
	$I_O \approx$ 0.3 A, V_{IN} = 0→ 5V, Fig. 3		5.0			5.0			5.0		
t_{pd1} Propagation Delay to Logical "1" (Output Turn "OFF")	$V_{OUT} \approx 0.5\,V^+$, V_{IN} = 10→0V, Fig. 3		4.0	10		4.0	10		4.0	10	ns
	$V_{OUT} \approx 0.5V^+$, V_{IN} = 5→0V, Fig. 3		5.0			5.0			5.0		
SPECIFICATIONS FOR USE WITH TTL (FIGS. 2 & 4)											
I_{IL} Logical "0" Input Current	V_{IN} = 0.4 V, V_{OUT} = V_{OH}, R_P = 1KΩ		4.6			4.6			4.6		mA
V_{OL} Output "ON" Voltage	I_O = 100 mA, V_{IN} = 5V		0.2	0.25		0.3	0.35		0.37	0.45	V
	I_O = 300 mA, V_{IN} = 5V		0.72	0.9		1.0	1.2		1.4	1.7	
t_{pd0} Propagation Delay to Logical "0" (Output Turn "ON")	V^+ = 10 V, R_L = 30Ω, $I_O \approx$ 0.3A See Fig. 4		8.0			8.0			8.0		ns
t_{pd1} Propagation Delay to Logical "1" (Output Turn "OFF")	V^+ = 10 V, R_L = 30Ω, $V_{OUT} \approx 0.5\,V^+$ See Fig. 4		5.0			5.0			5.0		ns



Switching Time Circuit
Fig. 3



TTL Switching Circuit
Fig. 4

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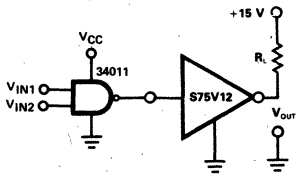
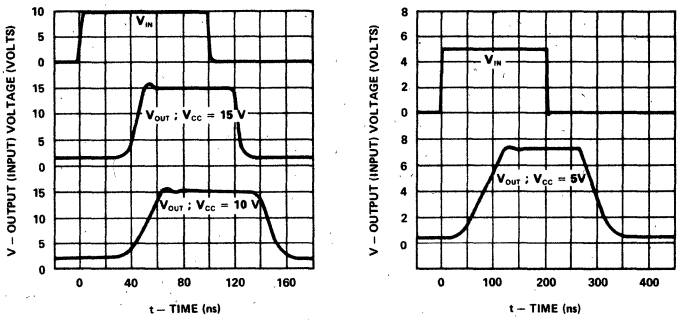
S55V01/S75V01 SERIES HIGH SPEED, POWER PERIPHERAL DRIVERS

APPLICATIONS

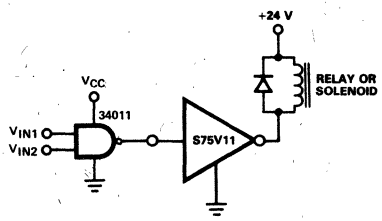
CMOS Compatible Switch/Relay Replacement



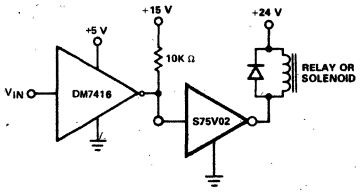
CMOS Switching Waveforms



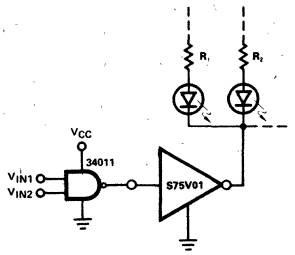
CMOS Compatible Relay/Solenoid Driver



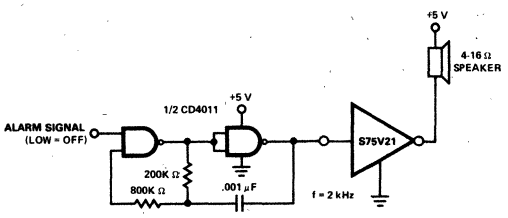
TTL Logic Compatible Solenoid Driver



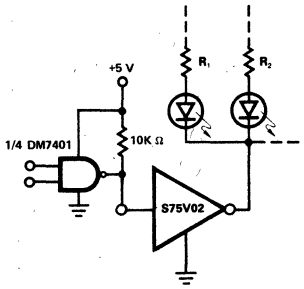
CMOS Compatible Lamp/Display Driver



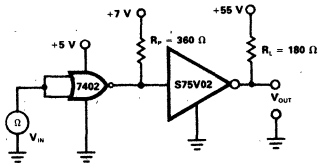
Audio Alarm

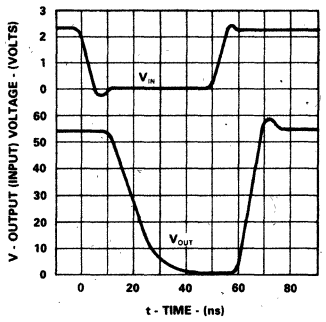


TTL Logic Compatible LED Driver



TTL Compatible Switch/Relay Replacement





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DG300 SERIES CMOS ANALOG SWITCHES

	FOR HIGH SPEED	FOR LOW POWER
TTL Compatibility		
DG300 DG301 DG302 DG303 DG381 DG387 DG384 DG390	t_{off} = 130 ns (typ), 250 ns (max) t_{on} = 150 ns (typ), 300 ns (max)	1.8 mW (typ)
CMOS Compatibility		
DG304 DG305 DG306 DG307	t_{off} = 70 ns (typ), 150 ns (max) t_{on} = 110 ns (typ), 250 ns (max)	1.0 μW (typ)

COMPARE THESE SPECIFICATIONS

	SILICONIX DG300 Series	Analog Devices 75—Series	Harris HI—Series	Intersil IH—Series	National LF—Series	Texas Instruments TL—Series
t_{off} (typ)	**70 ns**	**400 ns**	**280 ns**	**500 ns**	**90 ns**	**350 ns**
t_{on} (typ)	**110 ns**	**700 ns**	**370 ns**	**1000 ns**	**500 ns**	**175 ns**
Power Requirement	**1 μW**	**4 mW**	**1.5 mW**	**1.5 mW**	**135 mW**	**120 mW**

The DG300 Series also offers:

- **Low R_{on}**
- **Low Leakage**
- **High off isolation**
- **TTL as well as 5/15 V CMOS compatibility**
- **Many different functions**

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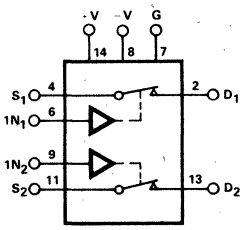
SWITCH FUNCTIONS

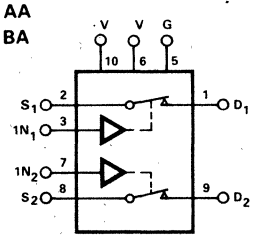
SWITCH STATES ARE FOR LOGIC "1" INPUT

DG300/304

AP
BP
BK
CJ
AL
BL

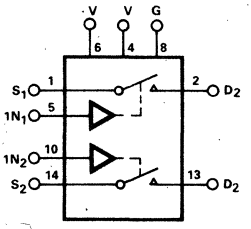


AA
BA

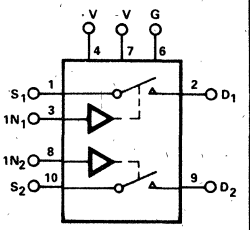


DG381

AP
BP
BK
CJ
AL
BL

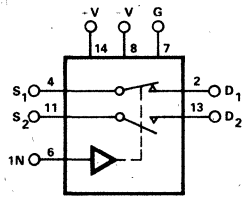


AA
BA

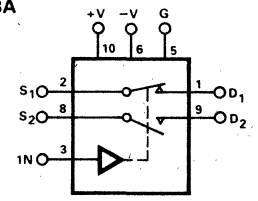


DG301/305

AP
BP
BK
CJ
AL
BL

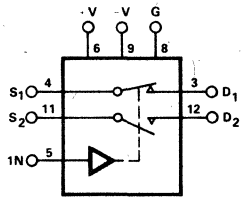


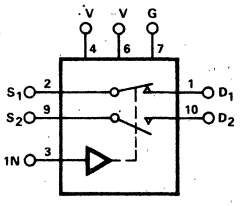
AA
BA



DG387

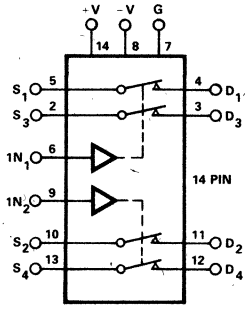
AP
BP
BK
CJ
AL
BL





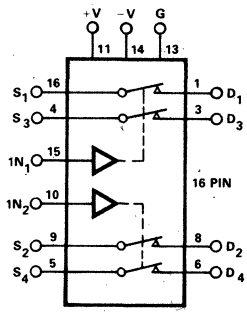
DG302-306

AP
BP
BK
CJ
AL
BL

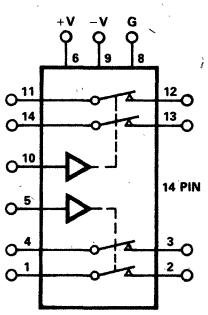


DG384

AP
BP
BK
CJ



AL
BL



DG303/307

AP
BP
BK
CJ
AL
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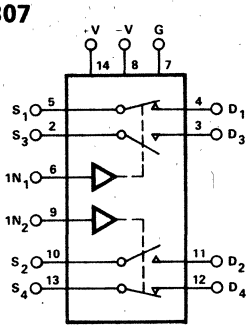

DG390

AP
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BK
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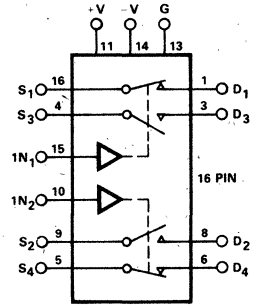
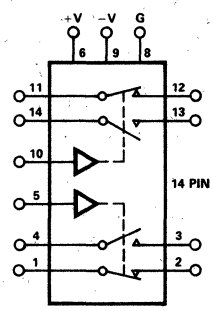


AL
BL



SIDEBRAZE DIP (AP, BP) **FLAT PACK (AL, BL)**
CERDIP (BK) **METAL CAN (AA,BA)**
PLASTIC DIP (CJ)

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INTRODUCTION TO LINEAR

The Master Selection Guide provides sufficient information to make initial product selections, to lead you to a group of device numbers and manufacturers' names. It enables you to find the products which are most appropriate to fulfill your major requirements and then provides data for many of the more important products.

All devices that appear in this section, both in the initial selection guide and in the data pages, are included in the Part Number and Product Indexes. These index listings lead to the page and the line on that page where each device appears.

In the Linear section over 1000 operational amplifiers are covered. Since there are so many devices, the operational amplifier entries have been given special consideration. Separate lists are provided for those which have High Speed, High Voltage capability, Wide Bandwidth, etc. Under General Purpose, four amplifier types are listed; these are the ones that the high volume manufacturers indicate are the most widely used; however, quad amplifiers should also be considered when appropriate. If you have located an op amp in a specialized category, you can review its characteristics by finding it in the Part Number or Product Indexes and looking it up in the Operational Amplifier Characteristics and in the Data Sections.

Following the special lists, the "Operational Amplifier-Characteristics" listings, categorize amplifiers by input parameters. They are arranged in order of increasing offset voltage, bias current, offset current and then voltage drift. The other parameters listed do not affect the sequence in which the devices are presented. The column labeled "Comp" indicates the number of external components normally used for compensation; for example, "0" means no compensation is required.

Consumer circuits such as audio amplifiers, AM, FM, and TV circuits as well as some digital devices (watches, calculators, etc.) are now covered by model number in the new Consumer Circuit Section. Linear devices and unusual circuits which do not fit elsewhere are listed under the heading "Other Linear Devices."

Category	Page
Amplifiers, Special Purpose	512
Arrays	
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Consumer Circuits	521
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Operational Amplifiers	
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High Speed	530
High Voltage	531
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Low Drift	531
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The manufacturers listed above are providing detailed information on their latest and most significant products. They have made this investment to help you. Some chose not to.

If you want to see more data in future editions, tell the manufacturers through their salesmen and distributors.

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LINEAR—Amplifiers Special Purpose

Function	Device	Source	Line
Special Purpose			
AC Amplifier, Quad, Single Supply			
	CA3048	† RCA	
	CA3052	RCA	
AGC/Squelch Amplifier (Gain Controlled Amplifier)			
	LM170	† National	
	LM270	National	
	LM370	National	
AGC Generator, for SSB receivers			10
	SL621C	Plessey	
	SL1621C	Plessey	
AGC Generator (voice operated gain adjusting device)			
	SL620C	Plessey	
	SL622C	Plessey	
	SL1620C	Plessey	
	SL1622C	Plessey	
Amplifier, triple for active filters			
	TAA960	Signetics	20
Current Amplifier (unity gain, 100 ma Output)			
	LH0002	† National	
	LH0002C	National	
Current Amplifier (unity gain, 200 ma output)			
	3553	† Burr-Brown	
Current Amplifier (unity gain, 300 ma output)			
	MC1438	Motorola	
	MC1538	† Motorola	
Current Amplifier (unity gain, 600 ma output)			
	1016C	DDC	30
	1016M	† DDC	
	HA-2630	† Harris	
	HA-2635	**Harris**	**(580)**
Differential Input/Differential Output Amplifier (bandwidth less than 2 MHz)			
	μA730C	Fairchild	
	μA730M	† Fairchild	
	ITT730-1	ITT	
	ITT730-5	ITT	
	MC1590	† Motorola	40
	CA3000	† RCA	
	CA3007	† RCA	
	NE515	Signetics	
	SE515	† Signetics	
Differential/Cascode Amplifier (dc to r.f.)			
	LM3028	† National	
	LM3053	† National	
	CA3028	† RCA	
	CA3028A	† RCA	
	CA3028B	† RCA	50
	TA7045	Toshiba	
Gated Linear Amplifier (operational amplifier)			
	ZN424	Ferranti	
Instrumentation, (Differential Input, Independent Gain, Adjustment)			
	AD520J	**AD**	**(578)**
	AD520K	**AD**	**(578)**
	AD520S	**† AD**	**(578)**
	AD521J	**AD**	**(578)**
	AD521K	**AD**	**(578)**
	(Cont'd)		60

Function	Device	Source	Line
Special Purpose (Cont'd)			
Instrumentation, (Differential Input, Independent Gain, Adjustment) (Continued)			
	AD521S	**† AD**	**(578)**
	AD522A	**AD**	**(578)**
	AD522B	**AD**	**(578)**
	AD522C	**AD**	**(578)**
	AD522S	**† AD**	**(578)**
	3660J	Burr-Brown	
	3660K	Burr-Brown	70
	3660S	† Burr-Brown	
	3626A	Burr-Brown	
	3626B	Burr-Brown	
	3626C	Burr-Brown	
	LH0036	† National	
	LH0036C	National	
	LH0037	† National	
	LH0037C	National	
Instrumentation, (Differential FET Input, Independent Gain Adjustment)			80
	3670J	Burr-Brown	
	3670K	Burr-Brown	
	3670S	† Burr-Brown	
	LF152	† National	
	LF252	National	
	LF352	National	
Instrumentation (unity gain)			
	3627	Burr-Brown	
Isolation Amplifier, Optically Coupled			
	3650	Burr-Brown	90
	3652	Burr-Brown	
Log/Antilog Amplifier (Antilog)			
	1452	DDC	
	8049C	Intersil	
Log/Antilog Amplifier, (Log)			
	4127	Burr-Brown	
	1451	DDC	
	8048C	Intersil	
	TL441C	TI	
	TL441M	† TI	100
Microphone/Headphone Amplifier			
	SL630C	Plessey	
	SL1630	Plessey	
	TA1066	Toshiba	
Microphone Amplifier (for microphones in telephones)			
	TBA830	Siemens	
	TAA970	Signetics	
	TCA980	Signetics	
Mixer (to 200 MHz)			110
	S042	Siemens	
MOS Amplifier, MOS and npn transistors, 3 terminal			
	TAA320	Signetics	
	TAA320A	Signetics	
Operational Transconductance Amplifier			
	CA3060	RCA	
	CA3060	† RCA	
	CA3060A	† RCA	
	CA3060B	† RCA	120
	CA3080	RCA	
	(Cont'd)		

Function	Device	Source	Line
Special Purpose (Cont'd)			
Operational Transconductance Amplifier (Continued)			
	CA3080A	† RCA	
Power Amplifier/Switch (equivalent to an operational amplifier with uncommitted Darlington power output transistor), Programmable Gain			
	CA3094	† RCA	130
	CA3094A	† RCA	
	CA3094B	† RCA	
Preamplifier JFET (to precede op amps and comparators)			
	HA-2000	† Harris	
	HA-2005	Harris	
Preamplifier, Precision (to precede operational amplifiers)			
	LM121	† National	
	LM221	National	140
	LM321	National	
	LM121A	† National	
	LM221A	National	
	LM321A	National	
Preamplifier, Temperature Controlled			
	μA727C	Fairchild	
	μA727M	† Fairchild	
Preamplifier with automatic level control, for tape recorders			
	TDA1054	SGS	150
	TA7055	Toshiba	
Preamplifier, JFET (Impedance Converter)			
	T100	Siliconix	
	T300	Siliconix	
R.F. Amplifier, Gated			
	MC1445	Motorola	
	MC1545	† Motorola	
Programmable Channel Op Amp (one of 4 input stages can be connected to single output)			160
	1454C	DDC	
	1454M	† DDC	
	HA-2400	**† Harris**	**(581)**
	HA-2404	**Harris**	**(580)**
	HA-2405	**Harris**	**(580)**
Read Amplifier/Preamplifier (for magnetic tape memory systems)			
	MC3467	Motorola	
	MC3468	Motorola	
Front End Amplifier, for ultrasonic or infrared remote control systems			170
	TDA4180	Telefunken	
Single-ended Input/Output Amplifier, Triple			
	CA3035	RCA	
Two Wire Transmitter (Sends current signal over same two lines from which it is powered)			
	LH0045	† National	
	LH0045C	National	
Video, IF and RF Amplifiers			
	733	† AMD	180
	733C	AMD	
	NE592	AMD	
	SE592	† AMD	
	(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Arrays (Cont'd)

Function	Device	Source	Line
Transistor Arrays (Cont'd)			
Dual Differential Amplifiers (NPN), biasing, to above 100 MHz (Continued)			
	SE510	† Signetics	
	SE511	† Signetics	
Dual Differential Amplifiers (NPN), to 500 MHz			
	LA3049	† Lithic Sys	
	CA3049	† RCA	
	CA3102	† RCA	
Dual Differential Darlington Amplifiers (NPN) with Diode Bias String			10
	CA3050	† RCA	
	CA3051	RCA	
One Darlington PNP Pair, and One Current Mirror Pair with Shared			
	MC1416	Motorola	
	CA3084	RCA	
Seven NPN Transistors, Common Emitter			
	SL3081	Plessey	
	CA3081	† RCA	20
	SG3081	Silicon G	
	ULN-2081A	Sprague	
Seven High Current NPN Transistors, Common Collector			
	SL3082	Plessey	
	CA3082	† RCA	
	SG3082	Silicon G	
	ULN-2082A	Sprague	
Seven High Current Darlingtons			
	ULN-2031A	Sprague	30
	ULN-2032A	Sprague	
	ULN-2033A	Sprague	
Seven High Current, High Voltage NPN Darlington Amplifiers, Open Collector			
	9665	Fairchild	
	9666	Fairchild	
	9667	Fairchild	
	9668	Fairchild	
	MC1411	Motorola	
	MC1412	Motorola	40
	MC1413	Motorola	
	MC1416	Motorola	
	L201	SGS	
	L202	SGS	
	L203	SGS	
	SG2001	Silicon G	
	SG2002	Silicon G	
	SG2003	Silicon G	
	SG3851	Silicon G	
	SG3852	Silicon G	50
	SG3853	Silicon G	
	ULN-2001A	Sprague	
	ULN-2002A	Sprague	
	ULN-2003A	Sprague	
	ULN-2004A	Sprague	
	ULN2001	TI	
	ULN2002	TI	
	ULN2003	TI	
	ULN2004	TI	
Eight NPN Transistors (arranged 2X4 as a memory driver)			60
	SN75303	TI	
	(Cont'd)		

Function	Device	Source	Line
Transistor Arrays (Cont'd)			
Eight NPN Transistors (arranged 2X4 as a memory driver) (Continued)			
	SN75308	TI	
Super Beta Differential Cascode Amplifier and Three NPN Transistors			
	CA3095	† RCA	
Special Arrays			70
CMOS (Three p-channel and three n-channel enhancement MOS Transistors tested for linear operation)			
	CA3600	† RCA	
Thyristor/Transistor Array (SCR, Programmable Unijunction Transistor, PNP/NPN Transistor Pair, NPN Transistor and Zener Diode)			
	CA3097	† RCA	
Transistor/Diode Array (Three NPN Transistors Two Zener Diodes and One Diode)			80
	CA3093	RCA	
Eight SCRs			
	TCP2410	TI	
	TCP2411	TI	

Function	Device	Source	Line
Special Arrays			

† Military Temperature Range (−55°C to 125°C)

LINEAR—Comparators

Offset Voltage mv (25°C)	Bias Current (25°C)	Offset Current (25°C)	Response Time ns	Max. Differential Voltage	Gain	Fan Out	Supply Voltage	Device	Source
Comparators-Single									
0.8	50nA	3nA	230	11	200K		±5 to ±18	CMP-02	† PMI
								CMP-02E	PMI
	600nA	25nA	150	11	200K*		±5 to ±18	CMP-01	† PMI
								CMP-01E	PMI
1.0	15μA	1μA	60	5	1400		-6,12	RM710A	Raytheon
2.0	10μA	1μA	6.5	6	NA		-5.2,6	685L	AMD
								685M	† AMD
			12	6	NA	5	-6,5	686M	† AMD
	15μA	3μA	80	5	12.5K		-6,12	TL810M	† TI
	20μA	3μA	40	5	40K*	10	-3 to -12,12	LM106	† AMD
								LM206	AMD
								LM106	† National
								LM206	National
								LM106	† Raytheon
								LM206	Raytheon
								LM106	† TI
								LM206	TI
			40*	5	1250	1	-6,12	μA710M	† Fairchild
								MC1710	† Motorola
								LM710	† National
								μA710	† Signetics
								SG710	† Silicon G
								710B	† Teledyne S
								SFC2710	† NPC
								μA710M	† TI
			60	5	1250	1	-6,12	RM710	† Raytheon
2.8	100nA	15nA	230	11	100K		5 to ±10	CMP-02C	PMI
	900nA	80nA	150	11	100K		5 to ±18	CMP-01C	PMI
3.0	50nA	10nA	200	10	35K		±5 to ±18	μA734M	† Fairchild
	100nA	10nA	165*	30	200K*	5	5,0 to ±15	LM111	† TI
			200*	30	200K*	5	5.0 to ±15	**AD111**	**† AD (579)**
								AD211	**AD (579)**
								μA111M	† Fairchild
								111	† Intersil
								211	Intersil
								MLM111	† Motorola
								MLM211	Motorola
								LM111	† National
								LM211	National
								SFC2111	† NPC
								SFC2211	NPC
								CA111	† RCA
								CA211	RCA
								LM111	† Raytheon
								LM211	Raytheon
								LM111	† Signetics
								LM211	Signetics
								SG111	† Silicon G
								SG211	Silicon G
								LM111	† Teledyne S
								LM211	Teledyne S
			250	30	200K*	5	5,0 to ±15	LM111	† AMD
								LM211	AMD
		20nA	250*	15	15K		5-15, ±5-±15	8001M	† Intersil

† Military Temperature Range (−55°C to 125°C) * Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Comparators (Cont'd)

Offset Voltage mv (25°C)	Bias Current (25°C)	Offset Current (25°C)	Response Time ns	Max. Differential Voltage	Gain	Fan Out	Supply Voltage	Device	Source
Comparators-Single (Cont'd)									
	5μA	2μA*	20	5	3K*	2	5, (-6,5-±15)	LM161	† National
								LM261	National
	10μA	1μA	12	6	NA	5	-6,5	686C	AMD
3.5	20μA	5μA	80	5	10K		-6,12	TL510C	TI
								TL810C	TI
4.0	50 PA	25 PA	200*	30	200K*	5	5,0 to ±15	μAF111	† Fairchild
								LF111	† National
								LF211	National
	2μA	0.5μA	26	5	5K*		5, (-6,5-±10)	SE527	† Signetics
	12μA	3μA	22	5	5K*		5, (6,5-±10)	SE529	† Signetics
5.0	10μA	2μA	20	5	3K*	2	(-6,5 to ±15)	LM361	National
	20μA	3μA	14*	5	3K*	4	±5	LM160	† National
								LM260	National
								LM360	National
	25μA	5μA	3.5*				-8,-5.2,5	SP750B	Plessey
			40	5	40K*	10	-3 to -12,12	LM306	National
								LM306	Raytheon
								LM306	TI
			40*	5	40K*	10	-3 to -12,12	LM306	AMD
					1000	1	-6,12	MC1710C	Motorola
								MC1710C	Motorola
								LM710C	National
								RC710	Raytheon
								SG710C	Silicon G
								μA710C	Signetics
								710C	Teledyne S
	35μA	5μA	48	5	NA	10	±5	NE526	Signetics
								SE526	† Signetics
	75μA	10μA	40*	5	750		-6,12	TL710M	† TI
	100nA	25nA	200*	10	35K		±5 to ±10	μA734C	Fairchild
	250nA	50nA	250*	15	15K		5-15, ±5-±15	8001C	Intersil
6.0	2μA	0.75μA	26	5	5K*		5, (-6,5-±10)	NE527	Signetics
	20μA	5μA	22	5	5K*		5, (-6,5-±10)	NE529	Signetics
	60μA	7.5μA	16*	5	5K*	2	±4.5 to ±6.5	μA760M	† Fairchild
								μA760C	Fairchild
	250nA	100nA	250	10	15K		±6 to ±18	AD351J	AD
								AD351K	AD
								AD351S	† AD
7.5	250nA	50nA	165*	30	200K*	5	5,0 to ±15	LM311	TI
			200*	30	200K*	5	5,0 to ±15	**AD311**	**AD** **(579)**
								μA311C	Fairchild
								311	Intersil
								MLM311	Motorola
								LM311	National
								SFC2311	NPC
								CA311	RCA
								LM311	Raytheon
								LM311	Signetics
								SG311	Silicon G
								LM311	Teledyne S
			250	30	200K*	5	5,0 to ±15	LM311	AMD

† Military Temperature Range (−55°C to 125°C) * Typical Values

LINEAR—Comparators (Cont'd)

Offset Voltage mv (25°C)	Bias Current (25°C)	Offset Current (25°C)	Response Time ns	Max. Differential Voltage	Gain	Fan Out	Supply Voltage	Device	Source
Comparators-Single (Cont'd)									
7.5	100μA	15μA	40*	5	700		-16,12	TL710C	TI
10.0	150pA	75pA	200*	30	200K*	5	5,0 to ±15	μAF311	Fairchild
								LF311	National
Comparators-Dual									
1.5	15μA	1μA	40	5	1400	1	-6,12	RM711A	† Raytheon
2.0	100nA	25nA	1300*	36	50K		2 to 36	LM193A	† National
								LM193A	† Signetics
	250nA	50nA	1300*	36	50K		2 to 36	LM293A	National
								LM393A	National
								LM293A	Signetics
								LM393A	Signetics
	10μA	1μA	8	6			-5.2,5	687AM	† AMD
			10	6			-5.2,5	687M	† AMD
	15μA	3μA	80	5	12.5K		-6,12	TL514M	† TI
								TL820M	† TI
	20μA	3μA	30*	5	1250	1	-6,12	LM1514	† National
			40	5	40K*	10	-3 to -12,12	SN52506	† TI
			40*	5	1250		-6,12	MC1514	† Motorola
								RM1514	† Raytheon
3.0	100nA	10nA	200*	30	200K*	5	5,0 to ±15	LH2111	† AMD
								LH2211	AMD
								LH2111	† National
								LH2211	National
								LH2111	† Signetics
								LH2211	Signetics
			250	30	200K*		5,0 to ±15	1500M	† AMD
								1500L	AMD
	10μA	1μA	8	6			-5.2,5	687AL	AMD
			10	6			-5.2,5	687L	AMD
3.5	20μA	3μA	80	5	12.5K		-6,12	TL811M	† TI
		5μA	80	5	10K		-6,12	TL514C	TI
								TL820C	TI
	75μA	10μA	40*	5	700	1	-6,12	MC1711	† Motorola
					750	1	-6,12	μA711M	† Fairchild
								LM711	† National
								RM711	† Raytheon
								μA711	† Signetics
								711B	† Teledyne S
			60	5	750	1	-6,12	SG711	Silicon G
			80	5	750	1	-6,12	μA711M	† TI
4.0	500nA	75nA	80*	5	10K	2	5,0 to ±15	LM119	† AMD
								LM219	AMD
								LM119	† National
								LM219	National
								LM119	† Signetics
								LM219	Signetics
5.0	100nA	25nA	1300*	36	50K		2 to 36	LM193	† National
								LM193	† Signetics
								LM193	† TI
	250nA	50nA	1300*	36	50K		2 to 36	LM293	National
								LM393	National
								LM293	Signetics

(Cont'd)

† Military Temperature Range (−55°C to 125°C) * Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Comparators (Cont'd)

Offset Voltage mv (25°C)	Bias Current (25°C)	Offset Current (25°C)	Response Time ns	Max. Differential Voltage	Gain	Fan Out	Supply Voltage	Device	Source
Comparators-Dual (Cont'd)									
5.0	250nA	50nA	1300*	36	50K		2 to 36	(Cont'd)	
								LM393	Signetics
								LM293	TI
								LM393	TI
	25μA	5μA	28*	5	40K*	10	-3 to -12,12	TL506C	TI
			30*	5	1000	1	-6,12	LM1414	National
			40*	5	1000		-6,12	MC1414	Motorola
								RC1414	Raytheon
	30μA	5μA	33*	5	10K		-6,12	TL811C	TI
	100μA	15μA	40*	5	700	1	-6,12	μA711C	Fairchild
								MC1711C	Motorola
								SFC2711	NPC
								LM711C	National
								RC711	Raytheon
								μA711C	Signetics
								SG711C	Silicon G
								μA711C	TI
								711C	Teledyne S
			65*	5	700	1	-6,12	HA17711	Hitachi
7.0	250nA	50nA	1500*	36	25K		2 to 36	LM2903	National
								LM2903	Signetics
7.5	250nA	50nA	200*	30	200K*	5	5,0 to ±15	LH2311	AMD
								LH2311	National
								LH2311	Signetics
			250	30	200K		5,0 to ±15	1500C	AMD
	20μA	5μA	18	6	5K*	10	±5	NE521	Signetics
			25	6	5K*	10	±5	NE522	Signetics
	100μA	15μA	40*	5	700		-6,12	TL720C	TI
8.0	1μA	0.2μA	80*	5	8K	2	5,0 to ±15	LM319	AMD
								LM319	National
								LM319	Signetics
Comparators-Quad									
2.0*	20μA	1μA*	55	5	1.2K*	10	±5	MC3430	Motorola
								MC3431	Motorola
			65	5	1.2K*	10	±5	MC3432	Motorola
								MC3433	Motorola
2.0	100nA	25nA	1300*	36	50K	2	2-36/±1-±18	LM139A	† AMD
								LM139A	† Intersil
								MLM139A	† Motorola
								LM139A	† National
								CA139A	† RCA
								SG139A	† Silicon G
					200K*	2	2-36/±1-±18	LM139A	Signetics
								LM139A	† Teledyne S
	250nA	50nA	1300*	36	50K	2	2-36/±1-±18	LM239A	AMD
								LM339A	AMD
								LM239A	Intersil
								LM339A	Intersil
								MLM239A	Motorola
								MLM339A	Motorola
								CA239A	RCA
								CA339A	RCA
								LM239A	National
								LM339A	National
								(Cont'd)	

† Military Temperature Range (−55°C to 125°C) * Typical Values

LINEAR—Comparators (Cont'd)

Offset Voltage mv (25°C)	Bias Current (25°C)	Offset Current (25°C)	Response Time ns	Max. Differential Voltage	Gain	Fan Out	Supply Voltage	Device	Source
Comparators-Quad (Cont'd)									
2.0	250nA	50nA	1300*	36	50K	2	2-36/±1-±18	(Cont'd)	
								SG239A	Silicon G
								SG339A	Silicon G
					200K*	2	2-36/±1-±18	LM239A	Signetics
								LM339A	Signetics
								LM239A	Teledyne S
								LM339A	Teledyne S
2.5	5nA	0.5nA	10 MS	36	25K		2 to 36	**L161**	**Siliconix (604)**
5.0	100nA	25nA	1300*	36	200K*	2	2-36/±1-±18	LM139	† AMD
								μA139M	† Fairchild
								LM139	† Intersil
								MLM139	† Motorola
								LM139	† Raytheon
								LM139	† National
								CA139	† RCA
								LM139	† Signetics
								SG139	† Silicon G
								LM139	† Teledyne S
								LM139	† TI
	250nA	50nA	1300*	36	200K*	2	2-36/±1-±18	LM239	AMD
								LM339	AMD
								μA339C	Fairchild
								LM239	Intersil
								LM339	Intersil
								MLM239	Motorola
								MLM339	Motorola
								LM239	National
								LM339	National
								LM239	Raytheon
								LM339	Raytheon
								CA239	RCA
								CA339	RCA
								LM239	Signetics
								LM339	Signetics
								SG239	Silicon G
								SG339	Silicon G
								LM239	Teledyne S
								LM339	Teledyne S
								LM239	TI
								LM339	TI
7.0	250nA	50nA	1300*	36	50K	2	2-36/±1-±18	MLM2901	Motorola
								LM2901	National
								LM2901	Raytheon
								LM2901	Teledyne S
								LM2901	TI
9.0	300nA	70nA	1300*	36			2-36/±1-±18	μA775C	Fairchild
20	500nA	3nA*	2000*	V_{CC}	2K	1	2 to 28	MC3302	Motorola
								μA3302C	Fairchild
								RV3302	Raytheon
								MC3302	Signetics
								SG3302	Silicon G
								3302	Teledyne S
		100nA	1300*	V_{CC}	2K	2	5 to ±15	LM3302	National

Special purpose comparators (Alarm Circuits; Analog-Digital Control Circuits; Comparators, Programmable; Level Detectors; Voltage Sensors, etc.) are listed under LINEAR-Other Devices

† Military Temperature Range (−55°C to 125°C) * Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Consumer Circuits

Function	Device	Source	Line
Consumer Circuits			
Amplifier, Hearing Aid			
	MCC263	Micro Comp	
	MPS5003	Micro Power	
	MPS5014	Micro Power	
	OM200	Panasonic	
	CA3078	† RCA	
	OM2001	Signetics	
	TAA370	Signetics	
Amplifier, AGC/Squelch			10
	LS170	† Lithic Sys	
	LS270	Lithic Sys	
	LS370	Lithic Sys	
	LM170	† National	
	LM270	National	
	LM370	National	
AM IF Amplifier			
	LM172	† National	
	LM272	National	
	LM372	National	20
AM Receiver System			
	μA720	Fairchild	
	μA7330	Fairchild	
	ZN414	Ferranti	
	HA1138	Hitachi	
	HA1151	Hitachi	
	LM1820	National	
	CA3088	† RCA	
	CA3123	† RCA	
	TDA1046	Siemens	30
	TBA651	SGS	
	NE546	Signetics	
	ULN-2137	Sprague	
	SN76635	TI	
AM/FM IF Amplifier			
	μA757	† Fairchild	
	AN203	Panasonic	
	AN210	Panasonic	
	AN353	Panasonic	
	TAA991	Siemens	40
	TA7142	Toshiba	
AM/FM IF and AF Amplifier			
	TBA460	Siemens	
AM/FM Receiver System			
	μA721	Fairchild	
	LM273	National	
	LM274	National	
	LM373	National	
	LM374	National	
	AN217	Panasonic	50
	AN253	Panasonic	
	AN260	Panasonic	
	AN277	Panasonic	
	SL624	Plessey	
	MCC401	Micro Comp	
	MCC402	Micro Comp	
	SL437	Plessey	
	TBA570	Signetics	
	TBA700	Signetics	
	TBA570	Telefunken	60

Function	Device	Source	Line
Consumer Circuits (Cont'd)			
AM/FM/SSB Detector			
	SL624C	Plessey	
AM/SSB Detector			
	SL623C	Plessey	
Appliance Timer			
	AY5-1230	GI	
	AY5-1231	GI	
	UCN-4105	Sprague	
Audio Amplifier and Preamplifier, low power			70
	TCA210	Signetics	
Audio Amplifier, low power			
	TBA915	Signetics	
Audio Controls, Stereo, dc operated			
	TCA730	Signetics	
	TCA740	Signetics	
	CT7000	GI	
Audio Driver			
	MC1385	Motorola	
	MC3320	Motorola	80
	MC3321	Motorola	
Audio, Noise Reduction, Dolby			
	μA7300	Fairchild	
Audio, Power Amplifier, <5 Watts			
	TBA641	Fairchild	
	TBA820	Fairchild	
	HA1306	Hitachi	
	HA1310	Hitachi	
	HA1311	Hitachi	
	HA1312	Hitachi	90
	HA1313	Hitachi	
	HA1314	Hitachi	
	HA1316	Hitachi	
	HA1325	Hitachi	
	HA1329	Hitachi	
	ITT3701	ITT	
	MC1306	Motorola	
	MC1384	Motorola	
	MC1454	Motorola	
	MC1554	† Motorola	100
	MC3360	Motorola	
	LM380	National	
	LM386	National	
	LM388	National	
	LM390	National	
	AN214	Panasonic	
	AN215	Panasonic	
	AN252	Panasonic	
	AN374	Panasonic	
	SL414	Plessey	110
	SL424	Plessey	
	CA3020	† RCA	
	CA3094	† RCA	
	TAA611	SGS	
	TBA641	SGS	
	TBA820	SGS	
	TCA830	SGS	
	NE540	Signetics	
	SE540	Signetics	
	TCA160	Signetics	120
	TCA760	Signetics	
	(Cont'd)		

Function	Device	Source	Line
Consumer Circuits (Cont'd)			
Audio, Power Amplifier, <5 Watts (Continued)			
	ULN-2280	Sprague	
	ULN-2281	Sprague	
	TCA830	Telefunken	
	SN76000	TI	
	SN76011	TI	
	SN76021	TI	
	SN76024	TI	130
	TA7083	Toshiba	
	TA7200	Toshiba	
	TA7204	Toshiba	
Audio, Power Amplifier, 5-10 Watts			
	μA706	Fairchild	
	TBA800	Fairchild	
	TBA810	Fairchild	
	HA1308	Hitachi	
	HA1317	Hitachi	
	HA1322	Hitachi	140
	HA1338	Hitachi	
	HA1339	Hitachi	
	TBA810	Hitachi	
	TBA800	ITT	
	TDA2002	Motorola	
	AN272	Panasonic	
	AN315	Panasonic	
	SL415	Plessey	
	SL425	Plessey	
	TBA800	Plessey	150
	CA810	RCA	
	CA3131	RCA	
	CA3132	RCA	
	TBA800	SGS	
	TBA810	SGS	
	TDA2002	SGS	
	TDA1004	Signetics	
	TDA800	Telefunken	
	TBA810	Telefunken	
	TDA1037	Siemans	160
	SN76005	TI	
	TA7201	Toshiba	
	TA7202	Toshiba	
	TA7205	Toshiba	
Audio Power Amplifier, >10 Watts			
	TCA940	SGS	
	TDA2010	SGS	
	TDA2020	SGS	
	TCA940	Telefunken	
Audio Power Amplifier, Dual, <5 Watts			170
	ITT3713	ITT	
	LM377	National	
	LM378	National	
	AN274	Panasonic	
	AN313	Panasonic	
	ULN-2274	Sprague	
	ULN-2275	Sprague	
	ULN-2277	Sprague	
	ULN-2278	Sprague	
	TA7203	Toshiba	180
Audio Power Amplifier, Dual, 5-10 Watts			
	LM379	National	

† Military Temperature Range (−55°C to 125°C)

LINEAR—Consumer Circuits (Cont'd)

Function	Device	Source	Line
Consumer Circuits (Cont'd)			
Audio Preamplifier			
	HA1406	Hitachi	
	AN127	Panasonic	
	AN136	Panasonic	
	AN262	Panasonic	
	AN270	Panasonic	
	CA3080	RCA	
	CA3080A	† RCA	
	TAA263	Signetics	10
	TAA310A	Signetics	
	TAA1002	Signetics	
	TA7063	Toshiba	
	TA7120	Toshiba	
	TA7122	Toshiba	
	TA7129	Toshiba	
	TA7136	Toshiba	
Audio, Preamplifier with ALC			
	TDA1054	SGS	
	TA7055	Toshiba	20
Audio, Preamplifier, Dual			
	μA739	Fairchild	
	μA381	Fairchild	
	μA7305	Fairchild	
	μA749	† Fairchild	
	HA1451	Hitachi	
	HA1452	Hitachi	
	MC1303	Motorola	
	LM1303	National	
	LM381	National	30
	LM382	National	
	LM387	National	
	AN215	Panasonic	
	AN264	Panasonic	
	AN360	Panasonic	
	AN370	Panasonic	
	CA3048	RCA	
	CA3052	RCA	
	NE542	Signetics	
	LM381	Signetics	40
	LM382	Signetics	
	LM387	Signetics	
	PA239	Signetics	
	TCA490	Signetics	
	ULN-2126	Sprague	
	ULN-2231	Sprague	
	SN76130	TI	
	SN76131	TI	
	SN76149	TI	
	TA7108	Toshiba	50
Automotive Adaptive Sense Amplifier (one-shot with peak detector adjusted shut-off threshold)			
	LM1815	National	
Automotive, Voltage Regulator			
	FA8008	Hitachi	
	FA8025	Hitachi	
	TCA700	ITT	
Calculator			
	C/CD583	GI	60
	C/CD585	GI	
	C/CD589	GI	
	C/CD593	GI	
	(Cont'd)		

Function	Device	Source	Line
Consumer Circuits (Cont'd)			
Calculator (Continued)			
	C/CD594	GI	
	C/CD595	GI	
	C/CD596	GI	
	C/CD598	GI	
	C/CD599	GI	70
	C/CD683/D	GI	
	C/CD685/D	GI	
	CF689	GI	
	C689D	GI	
	HD3633	Hitachi	
	MPS2529	MOS	
	MK50075	Mostek	
	MK50101	Mostek	
	MK50102	Mostek	
	MK50103	Mostek	80
	MK50104	Mostek	
	MK50280	Mostek	
	MK50314	Mostek	
	MK50321	Mostek	
	MM5725	National	
	MM5736	National	
	MM5737	National	
	MM5738	National	
	MM5739	National	
	MM5760	National	90
	MM5762	National	
	MM5763	National	
	MM5764	National	
	MM5765	National	
	MM5766	National	
	MM5767	National	
	MM5780	National	
	MM5791	National	
	MM57103	National	
	MM57104	National	100
	MN5530	Panasonic	
	MN5540	Panasonic	
	MN5550	Panasonic	
	MN5556	Panasonic	
	MN5701	Panasonic	
	MN5710	Panasonic	
	MN5750	Panasonic	
	MN5752	Panasonic	
	A4521	Rockwell	
	A550	Rockwell	110
Calculator, Display Interface, (use with printer)			
	C719	GI	
Calculator, Printing			
	C716	GI	
	C717	GI	
	C717X	GI	
	C718	GI	
	1022	SMC	
Camera, Exposure Control			
	MCC100	Micro Comp	120
	MCC102	Micro Comp	
	MCC122	Micro Comp	
	MCC127	Micro Comp	
	MCC129	Micro Comp	
	MCC130	Micro Comp	
	MCC131	Micro Comp	
	(Cont'd)		

Function	Device	Source	Line
Consumer Circuits (Cont'd)			
Camera, Exposure Control (Continued)			
	MCC132	Micro Comp	
	MCC137	Micro Comp	130
	MCC580	Micro Comp	
Clock			
	S1408	AMI	
	S1427A	AMI	
	S1998	AMI	
	S1998A	AMI	
	S1998B	AMI	
	S1998C	AMI	
	S2622	AMI	
	S11012	AMI	140
	S1856	AMI	
	AY5-1200A	GI	
	AY5-1202A	GI	
	AY5-1203A	GI	
	AY5-1204A	GI	
	AY5-1224A	GI	
	CK3500	GI	
	7028	Intersil	
	7049	Intersil	
	7050	Intersil	150
	7051	Intersil	
	SAJ300	ITT	
	TAA780	ITT	
	C1200	LSI Comp	
	MC14440	Motorola	
	MM5218	National	
	MM5309	National	
	MM5311	National	
	MM5312	National	
	MM5313	National	160
	MM5314	National	
	MM5315	National	
	MM5377	National	
	MM5378	National	
	MM5379	National	
	MM5382	National	
	MM5383	National	
	MN6070	Panasonic	
	SAA1028	Signetics	
	SAJ250	Signetics	170
Clock, Alarm Clock			
	S1998	AMI	
	S1998A	AMI	
	S1998B	AMI	
	S1998C	AMI	
	S2622	AMI	
	S11012	AMI	
	3817	Fairchild	
	CK3000	GI	
	CK3100	GI	180
	CK3200	GI	
	CK3400	GI	
	7038	Intersil	
	MPS7111	Micro Power	
	MK50250	Mostek	
	MK50253	Mostek	
	MK50254	Mostek	
	MM5316	National	
	MM5370	National	
	(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Consumer Circuits (Cont'd)

Function	Device	Source	Line
Consumer Circuits (Cont'd)			
Clock, Alarm Clock (Continued)			
	MM5371	National	
	MM5375	National	
	MM5376	National	
Clock, Clock Radio			
	S1998	AMI	
	S1998A	AMI	
	S1998B	AMI	
	S1998C	AMI	10
	3817	Fairchild	
	CK3300	GI	
	MK50361	Mostek	
	MK50362	Mostek	
	MK50380	Mostek	
	MK50381	Mostek	
FM Detector: See LINEAR-Phase Locked Loop Circuits and IF Amplifier/Detector below.			
FM IF Amplifier			
	μA753	Fairchild	20
	HA1150	Hitachi	
	HA1211	Hitachi	
	MC1350	Motorola	
	MC1355	Motorola	
	MC3310	Motorola	
	CA3002	† RCA	
	CA3005	† RCA	
	CA3006	† RCA	
	CA3012	† RCA	
	CA3028	† RCA	30
	CA3076	† RCA	
	AN278	Panasonic	
	ULN2208	Signetics	
	ULN2209	Signetics	
	ULN-2208	Sprague	
	ULN-2209	Sprague	
	SN76676	TI	
	SN76678	TI	
FM IF Amplifier/Detector			
	μA2136	Fairchild	40
	μA3065	Fairchild	
	μA3075	Fairchild	
	μA3089	Fairchild	
	HA1137	Hitachi	
	ITT3065	ITT	
	MC1351	Motorola	
	MC1356	Motorola	
	MC1375	Motorola	
	LM1351	National	
	LM1841	National	50
	LM2111	National	
	LM2113	National	
	LM273	National	
	LM274	National	
	LM373	National	
	LM374	National	
	LM3065	National	
	LM3075	National	
	LM3089	National	
	TBA120	National	60
	TAA661	Plessey	
	TBA120	Plessey	
	TBA750	Plessey	
	(Cont'd)		

Function	Device	Source	Line
Consumer Circuits (Cont'd)			
FM IF Amplifier/Detector (Continued)			
	CA2111A	† RCA	
	CA3014	† RCA	
	CA3041	RCA	
	CA3042	RCA	
	CA3043	† RCA	70
	CA3065	RCA	
	CA3075	† RCA	
	CA3089	† RCA	
	TDA1200	SGS	
	S041	Siemens	
	TBA120	Siemens	
	TDA1047	Siemens	
	CA3089	Signetics	
	TBA120	Signetics	
	TBA750	Signetics	80
	TCA420	Signetics	
	TCA770	Signetics	
	ULN2111	Signetics	
	ULN-2111	Sprague	
	ULN-2113	Sprague	
	ULN-2129	Sprague	
	ULN-2136	Sprague	
	ULN-2289	Sprague	
	TBA120	Telefunken	
	SN76642	TI	90
	SN76643	TI	
	SN76669	TI	
	SN76675	TI	
	SN76689	TI	
	TA7028	Toshiba	
FM, IF Amplifier, PLL, Squelch, narrow band			
	SL660	Plessey	
	SL662	Plessey	
	SL664	Plessey	
FM Muting/Tuning Point System			100
	HA1149	Hitachi	
FM, RF/IF Amplifier			
	AN219	Panasonic	
	CA3127	† RCA	
	TCA770	Signetics	
FM Stereo Decoder			
	XR1310	Exar	
	μA732	Fairchild	
	μA758	Fairchild	
	μA767	Fairchild	110
	μA1310	Fairchild	
	HA1115	Hitachi	
	HA1120	Hitachi	
	HA1142	Hitachi	
	HA1156	Hitachi	
	HA1173	Hitachi	
	MC1304	Motorola	
	MC1305	Motorola	
	MC1307	Motorola	
	MC1310	Motorola	120
	LM1304	National	
	LM1305	National	
	LM1307	National	
	LM1310	National	
	LM1800	National	
	LM1810	National	
	(Cont'd)		

Function	Device	Source	Line
Consumer Circuits (Cont'd)			
FM Stereo Decoder (Continued)			
	AN211	Panasonic	
	AN271	Panasonic	130
	SL758	Plessey	
	SL1310	Plessey	
	CA1310	RCA	
	CA3090A	† RCA	
	CA758	RCA	
	TBA450	Siemens	
	μA758	Signetics	
	TCA290	Signetics	
	TDA1005	Signetics	
	ULN-2120	Sprague	140
	ULN-2121	Sprague	
	ULN-2122	Sprague	
	ULN-2128	Sprague	
	ULN-2210	Sprague	
	ULN-2244	Sprague	
	SN76104	TI	
	SN76105	TI	
	SN76110	TI	
	SN76111	TI	
	SN76113	TI	150
	SN76115	TI	
	SN76116	TI	
	TA7154	Toshiba	
	TA7156	Toshiba	
	TA7159	Toshiba	
FM Tuner			
	TDA1062	Telefunken	
Four Channel Sound			
	μA1312	Fairchild	
	HA1327	Hitachi	160
	HA1328	Hitachi	
	HA1333	Hitachi	
	HA1334	Hitachi	
	MC1312	Motorola	
	MC1314	Motorola	
	MC1315	Motorola	
	QSI5022	Panasonic	
	TA7117	Toshiba	
Games, T.V.			
	AY3-8500	GI	170
	AY3-8600	GI	
	AY3-8710	GI	
	AY3-8720	GI	
	AY3-8800	GI	
	MPS7100	MOS	
	LM1889	National	
	MM53104	National	
	MM57100	National	
	MM57105	National	
	SN76400	TI	180
	SN76401	TI	
	SN76402	TI	
	SN76423	TI	
	SN76425	TI	
	SN76426	TI	
	SN76427	TI	
	SN76428	TI	
	SN76450	TI	
	SN76460	TI	

† Military Temperature Range (−55°C to 125°C)

LINEAR—Consumer Circuits (Cont'd)

Function	Device	Source	Line
Consumer Circuits (Cont'd)			
Ground Fault Interrupter			
	μA7390	Fairchild	
	MC3425	Motorola	
	MC3426	Motorola	
	LM1850	National	
Motor Speed Regulator			
	μA7391	Fairchild	
	MCC140	Micro Comp	
	LM1815	National	10
	SL440	Plessey	
	TCA900	SGS	
	TCA910	SGS	
	TDA1003	Signetics	
Motor, Stopping Motor Drive			
	SAA1027	Signetics	
Music, Electronic Piano Keyboard Interface			
	AY1-1320	GI	
Music, See Organ Circuits			
Organ, Arpeggio, Chord and Bass Accompaniment Generator			20
	M251	SGS	
Organ, Chord Generator			
	AY5-1317A	GI	
	S163	Siemens	
Organ, Delay Circuit			
	TCA350	ITT	
	SAD512	Reticon	
	SAD1024	Reticon	
Organ, Electronic Attenuator			30
	MC3340	Motorola	
	CA3080	RCA	
	CA3080A	† RCA	
Organ, Frequency Divider, 4 Stage			
	AY1-5051	GI	
Organ, Frequency Divider, 5 Stage			
	AY1-6721/5	GI	
Organ, Frequency Divider, 6 Stage			
	S10129	AMI	
	S10130	AMI	40
	S10131	AMI	
	AY1-1006	GI	
	AY1-2006	GI	
	AY1-6721/6	GI	
	HD3111	Hitachi	
	MM5554	National	
Organ, Frequency Divider, 7 Stage			
	S2193	AMI	
	AY1-1007B	GI	
	AY1-5050	GI	50
	ITT3715	ITT	
	ITT547	ITT	
	MC1302	Motorola	
	HBF4737	SGS	
	SAJ210	SGS	
	SAJ410	Siemens	
	SAJ110	Signetics	
Organ, Frequency Generator			
	S2555	AMI	
	(Cont'd)		

Function	Device	Source	Line
Consumer Circuits (Cont'd)			60
Organ, Frequency Generator (Continued)			
	S2556	AMI	
	AY1-0212	GI	
	TCA430	ITT	
	MM5555	National	
	MM5556	National	
	MM5832	National	
	MM5833	National	
	M081	SGS	
	M082	SGS	70
	M087	SGS	
	SAJ205	Siemens	
Organ, Gate for Key Contact			
	TDA0470	ITT	
	H629	SGS	
	H632	SGS	
Organ, Latch Pedal Sustain			
	M147	SGS	
Organ, Priority Latching Network			
	AY1-1313	GI	80
Organ, Rhythm Circuit			
	S2566	AMI	
	S2567	AMI	
	S8890	AMI	
	S9660	AMI	
	AY5-1315	GI	
	MM5871	National	
	M252	SGS	
	M253	SGS	
	M254	SGS	90
	M255	SGS	
Organ, Top Octave Generator			
	S50240	AMI	
	S50241	AMI	
	S50242	AMI	
	AY3-0214	GI	
	AY3-0215	GI	
	AY3-0216	GI	
	MK50240	Mostek	
	MK50241	Mostek	100
	MK50242	Mostek	
	MM5891	National	
Radio Receiver, Noise Inverter for car radios			
	TDA1068	Telefunken	
Radio, Receiver, Counter/Display			
	AY5-8100	GI	
	AY5-8110	GI	
	AY5-8112	GI	
Remote Control Transmitters, Receivers see T.V. Remote Control			110
RF Amplifier/Mixer			
	CA3005	† RCA	
	CA3006	† RCA	
	CA3049	† RCA	
	CA3127	† RCA	
	LA3049	† Lithic Sys	
	SD6000	Signetics	
RF Detector/Video Amplifier			
	SL510	Plessey	
	(Cont'd)		

Function	Device	Source	Line
Consumer Circuits (Cont'd)			120
RF Detector/Video Amplifier (Continued)			
	SL511	Plessey	
	CA3068	RCA	
Servo Driver			
	NE543	Signetics	
	NE544	Signetics	
Sonar Transceiver			
	LM1812	National	
Speedometer Circuit			
	SAY115	ITT	130
SSB Detector			
	SL623	Plessey	
Synthesizers, See Linear - Phase Locked Loop/Synthesizer Circuits			
Switches, Capacitance or Touch Sensing			
	S9260	**AMI (411)**	
	S9261	**AMI (411)**	
	S9262	**AMI (406,411)**	
	S9263	**AMI (411)**	
	S9264	**AMI (411)**	140
	S9265	**AMI (411)**	
	S9266	**AMI (406)**	
	SAS560	Siemens	
	SAS570	Siemens	
	SAS580	Siemens	
	SAS590	Siemens	
	TCA205	Siemens	
	SAS660	Telefunken	
	SAS670	Telefunken	
	SAS6600	Telefunken	150
	SAS6610	Telefunken	
	SAS6700	Telefunken	
	SAS6710	Telefunken	
	U113	Telefunken	
Tachometer Circuit			
	LM2907	National	
	LM2917	National	
	AN603	Panasonic	
	SN76810	TI	
Telephone, See Linear - Telecommunication Circuits			160
Transmitter, AM/CW/Pulse			
	LP2000	Lithic Sys	
	LP2001	Lithic Sys	
Transmitter/Receiver, AM			
	LP2700	Lithic Sys	
Tuning Voltage Stabilizer, for use with variable capacitance diodes			
	TAA550	Signetics	
	TCA530	Signetics	170
	TCA750	Signetics	
	TAA550	SGS	
T.V. AFT System			
	μA3064	† Fairchild	
	HA1108	Hitachi	
	HA1126	Hitachi	
	ITT3064	† ITT	
	MC1364	Motorola	
	(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Consumer Circuits (Cont'd)

Function	Device	Source	Line
Consumer Circuits (Cont'd)			
T.V. AFT System (Continued)			
	LM3064	National	
	AN220	Panasonic	
	AN221	Panasonic	
	AN222	Panasonic	
	AN320	Panasonic	
	AN325	Panasonic	
	AN326	Panasonic	
	CA3044	† RCA	10
	CA3064	† RCA	
	CA3139	RCA	
	ULN-2264	Sprague	
	SN76565	TI	
	TA7050	Toshiba	
	TA7070	Toshiba	
T.V. Camera Sync. Generator			
	3262A	Fairchild	
	3262B	Fairchild	
	ZNA103E	Ferranti	20
	HSUB0525	Hughes	
	MM4320	† National	
	MM5320	National	
	MM5321	National	
	MN6060	Panasonic	
T.V. Channel Display			
	AY5-8300	GI	
	AY5-8301	GI	
T.V. Channel Display with Time			
	AY5-8310	GI	30
	AY5-8311	GI	
	AY5-8321	GI	
	AY5-8322	GI	
	AY5-8324	GI	
	AY5-8320	GI	
	MM5841	National	
T.V. Channel Selection			
	SAS560	Siemens	
	SAS570	Siemens	
	SAS580	Siemens	40
	SAS590	Siemens	
	TDA2620	Signetics	
	TDA2630	Signetics	
	TDA2631	Signetics	
	ML231	TI	
	ML232	TI	
	SN76701	TI	
	SN76702	TI	
	SN76710	TI	
	SN76721	TI	50
	SN76727	TI	
	TM4357	Toshiba	
T.V. Chroma Circuits			
	μA746	Fairchild	
	μA780	Fairchild	
	μA781	Fairchild	
	μA787	Fairchild	
	μA788	Fairchild	
	μA3067	Fairchild	
	TAA630	Fairchild	60
	TBA510	Fairchild	
	TBA520	Fairchild	
	(Cont'd)		

Function	Device	Source	Line
Consumer Circuits (Cont'd)			
T.V. Chroma Circuits (Continued)			
	TBA540	Fairchild	
	TBA560	Fairchild	
	TBA990	Fairchild	
	TDA2510	Fairchild	
	TDA2521	Fairchild	
	HA1153	Hitachi	70
	HA1157	Hitachi	
	HA1158	Hitachi	
	HA1177	Hitachi	
	MC1323	Motorola	
	MC1324	Motorola	
	MC1326	Motorola	
	MC1327	Motorola	
	MC1328	Motorola	
	MC1329	Motorola	
	MC1370	Motorola	80
	MC1371	Motorola	
	MC1398	Motorola	
	MC1399	Motorola	
	LM746	National	
	LM1828	National	
	LM1848	National	
	LM3067	National	
	LM3070	National	
	LM3071	National	
	LM3126	National	90
	TBA510	National	
	TBA530	National	
	TBA540	National	
	TBA560	National	
	TBA990	National	
	AN225	Panasonic	
	AN227	Panasonic	
	AN234	Panasonic	
	AN235	Panasonic	
	AN236	Panasonic	100
	AN237	Panasonic	
	AN242	Panasonic	
	AN288	Panasonic	
	AN289	Panasonic	
	AN342	Panasonic	
	AN343	Panasonic	
	AN380	Panasonic	
	SL901	Plessey	
	SL917	Plessey	
	SL1327	Plessey	110
	TBA520	Plessey	
	TBA530	Plessey	
	TBA540	Plessey	
	TBA560	Plessey	
	TBA990	Plessey	
	TCA800	Plessey	
	CA1398	RCA	
	CA3066	RCA	
	CA3067	RCA	
	CA3070	RCA	120
	CA3071	RCA	
	CA3072	RCA	
	CA3121	RCA	
	CA3125	RCA	
	CA3126	RCA	
	CA3128	RCA	
	(Cont'd)		

Function	Device	Source	Line
Consumer Circuits (Cont'd)			
T.V. Chroma Circuits (Continued) (Continued)			
	CA3137	RCA	130
	CA3143	RCA	
	CA3144	RCA	
	CA3170	RCA	
	TAA6301	Siemens	
	TAA630	Signetics	
	TBA327	Signetics	
	TBA395	Signetics	
	TBA396	Signetics	
	TBA500	Signetics	
	TBA510	Signetics	140
	TBA520	Signetics	
	TBA530	Signetics	
	TBA540	Signetics	
	TBA550	Signetics	
	TBA560	Signetics	
	TBA990	Signetics	
	TCA640	Signetics	
	TCA650	Signetics	
	TCA660	Signetics	
	TCA800	Signetics	150
	TDA2500	Signetics	
	TDA2510	Signetics	
	TDA2520	Signetics	
	TDA2522	Signetics	
	TDA2560	Signetics	
	ULN-2114	Sprague	
	ULN-2124	Sprague	
	ULN-2127	Sprague	
	ULN-2224	Sprague	
	ULN-2228	Sprague	160
	ULN-2269	Sprague	
	ULN-2298	Sprague	
	TBA520	Telefunken	
	TBA530	Telefunken	
	TBA540	Telefunken	
	TBA560	Telefunken	
	TBA990	Telefunken	
	TDA2140	Telefunken	
	TDA2150	Telefunken	
	TDA2160	Telefunken	170
	SN76242	TI	
	SN76243	TI	
	SN76246	TI	
	SN76267	TI	
	SN76298	TI	
	TA7053	Toshiba	
	TA7102	Toshiba	
	TA7103	Toshiba	
	TA7141	Toshiba	
	TA7150	Toshiba	180
	TA7161	Toshiba	
	TA7168	Toshiba	
	TA7169	Toshiba	
T.V. Color Bar Generator			
	MM5332	National	
T.V. Convergence Circuit			
	HA1146	Hitachi	
	HA1147	Hitachi	
	HA1148	Hitachi	

† Military Temperature Range (−55°C to 125°C)

LINEAR—Consumer Circuits (Cont'd)

Function	Device	Source	Line
Consumer Circuits (Cont'd)			
T.V. Games, see Games, T.V.			
T.V. Horizontal Processor			
	μA1391	Fairchild	
	μA1394	Fairchild	
	TBA920	Fairchild	
	HA1160	Hitachi	
	ITT3710	ITT	
	TDA9400	ITT	
	TDA9500	ITT	10
	MC1391	Motorola	
	MC1394	Motorola	
	LM1391	National	
	LM1394	National	
	TBA920	National	
	SL451	Plessey	
	TBA920	Plessey	
	TBA940	Plessey	
	TBA950	Plessey	
	CA1391	RCA	20
	CA1394	RCA	
	CA3147	RCA	
	CA920	RCA	
	TBA720A	Signetics	
	TBA920	Signetics	
	TDA2571	Signetics	
	TDA2581	Signetics	
	TDA2590	Signetics	
	SN76525	TI	
	TA7151	Toshiba	30
T.V. Horizontal & Vertical Processor			
	AN202	Panasonic	
	AN232	Panasonic	
	AN332	Panasonic	
	AN334	Panasonic	
	TCA511	SGS	
T.V. Picture Sharpness			
	TA7126	Toshiba	
T.V. Remote Control			
	AY5-8410	GI	40
	AY5-8411	GI	
	AY5-8420	GI	
	AY5-8450	GI	
	AY5-8460	GI	
	AY5-8461	GI	
	SAA1024	GI	
	SAA1025	GI	
	SAA1024	ITT	
	SAA1025	ITT	
	MC14422	Motorola	50
	MC6525	Motorola	
	MC6526	Motorola	
	LM1812	National	
	CA3035	† RCA	
	M1024	SGS	
	M1025	SGS	
	SAB2000	Telefunken	
	SAB2010	Telefunken	
	SAB2020	Telefunken	
	SN76730	TI	60
	TM4500	Toshiba	

Function	Device	Source	Line
Consumer Circuits (Cont'd)			
T.V. Signal Processor (Jungle Circuit)			
	HA1155	Hitachi	
	HA1159	Hitachi	
	HA1180	Hitachi	
	MC1344	Motorola	
	LM1845	National	
	AN228	Panasonic	
	AN229	Panasonic	70
	AN230	Panasonic	
	AN231	Panasonic	
	AN249	Panasonic	
	AN328	Panasonic	
	AN331	Panasonic	
	AN349	Panasonic	
	AN350	Panasonic	
	TBA550	Plessey	
	CA3120	RCA	
	CA3142	RCA	80
	TBA311	SGS	
	TBA550	Signetics	
	TBA890	Signetics	
	TBA900	Signetics	
	ULN-2125	Sprague	
	SN76524	TI	
	SN76544	TI	
	SN76545	TI	
T.V. Sound Circuit			
	μA3065	Fairchild	90
	HA1124	Hitachi	
	HA1125	Hitachi	
	HA1154	Hitachi	
	ITT3065	ITT	
	ITT3701	ITT	
	MC1331	Motorola	
	MC1351	Motorola	
	MC1357	Motorola	
	MC1358	Motorola	
	LM1351	National	100
	LM1808	National	
	LM2111	National	
	LM3065	National	
	TBA120	National	
	AN239	Panasonic	
	AN206	Panasonic	
	AN240	Panasonic	
	AN241	Panasonic	
	AN255	Panasonic	
	AN341	Panasonic	110
	AN340	Panasonic	
	TAA570	Plessey	
	TAA661	Plessey	
	TBA120	Plessey	
	SBA750	Plessey	
	SL437	Plessey	
	CA2111	† RCA	
	CA3041	RCA	
	CA3042	RCA	
	CA3043	† RCA	120
	CA3065	RCA	
	CA3075	† RCA	
	CA3134	RCA	
	TDA1190	SGS	
	TBA120	Siemens	
	(Cont'd)		

Function	Device	Source	Line
Consumer Circuits (Cont'd)			
T.V. Sound Circuit (Continued)			
	TBA120	Signetics	
	TBA750	Signetics	
	TDA2610	Signetics	130
	ULN2111	Signetics	
	ULN-2111	Sprague	
	ULN-2165	Sprague	
	ULN-2211	Sprague	
	ULN-2212	Sprague	
	TBA120	Telefunken	
	SN76643	TI	
	SN76651	TI	
	SN76660	TI	
	SN76665	TI	140
	SN76666	TI	
	SN76688	TI	
	TA7051	Toshiba	
	TA7071	Toshiba	
	TA7072	Toshiba	
	TA7073	Toshiba	
	TA7130	Toshiba	
	TA7146	Toshiba	
T.V. Tone Control			
	TA7125	Toshiba	150
T.V. Touch Tuner			
	ML231	Plessey	
	ML232	Plessey	
	ML236	Plessey	
	ML237	Plessey	
	ML238	Plessey	
	ML239	Plessey	
	TDA2620	Signetics	
	TDA2630	Signetics	
	TDA2631	Signetics	160
	SAS660	Telefunken	
	SAS670	Telefunken	
T.V. Tuning Indicator			
	AY3-8330	GI	
T.V. Tuning System			
	OMEGA	GI	
T.V. Vertical Deflection			
	TDA1170	Fairchild	
	AN232	Panasonic	
	AN332	Panasonic	170
	AN334	Panasonic	
	TDA2600	Signetics	
	TDA1170	SGS	
	TDA1270	SGS	
	TA7152	Toshiba	
	TA7166	Toshiba	
T.V. Video Circuits			
	TBA970	Fairchild	
	HA1144	Hitachi	
	HA1152	Hitachi	180
	ITT1330	ITT	
	ITT1352	ITT	
	TCA270	ITT	
	MC1330	Motorola	
	MC1331	Motorola	
	MC1349	Motorola	
	MC1350	Motorola	
	(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Consumer Circuits (Cont'd)

Consumer Circuits (Cont'd)

Function	Device	Source	Line
T.V. Video Circuits (Continued)			
	MC1352	Motorola	
	LM1807	National	
	LM1889	National	
	TBA440	National	
	AN239	Panasonic	
	AN245	Panasonic	
	AN247	Panasonic	
	AN248	Panasonic	10
	AN349	Panasonic	
	AN350	Panasonic	
	SL437	Plessey	
	SL456	Plessey	
	SL457	Plessey	
	TBA440	Plessey	
	TCA270	Plessey	
	TDA440	Plessey	
	CA270	RCA	
	CA1352	RCA	20
	MC1353	Motorola	
	CA3068	RCA	
	TBA1440	Siemens	
	TBA1441	Siemens	
	TBA440	Signetics	
	TBA1440	Signetics	
	TCA270	Signetics	
	TCA540	Signetics	
	TDA2540	Signetics	
	TDA2541	Signetics	30
	TDA440	SGS	
	TDA440	Telefunken	
	TDA4400	Telefunken	
	TDA4410	Telefunken	
	SN76600	TI	
	SN76644	TI	
	SN76650	TI	
	TA7069	Toshiba	
	TA7074	Toshiba	
	TA7076	Toshiba	40
	TA7124	Toshiba	
	TA7145	Toshiba	
	TA7147	Toshiba	
	TA7162	Toshiba	
	TA7175	Toshiba	
Video Tape Recorder			
	AN301	Panasonic	
	AN302	Panasonic	
	AN303	Panasonic	
	AN304	Panasonic	50
	AN305	Panasonic	
	AN316	Panasonic	
	AN605	Panasonic	
Watch			
	S11011	AMI	
	S1409	AMI	
	S1424A	AMI	
	S1427A	AMI	
	HDO4821	Harris	
	HDO4822	Harris	60
	HDO4823	Harris	
	HDO4830	Harris	
	HDO4831	Harris	
	(Cont'd)		

Consumer Circuits (Cont'd)

Function	Device	Source	Line
Watch (Continued)			
	MD4111	Hitachi	
	HD4205	Hitachi	
	255	Hughes	
	288	Hughes	
	292	Hughes	70
	293	Hughes	
	298	Hughes	
	300	Hughes	
	306	Hughes	
	313	Hughes	
	318	Hughes	
	325	Hughes	
	350	Hughes	
	352	Hughes	
	353	Hughes	80
	354	Hughes	
	362	Hughes	
	371	Hughes	
	372	Hughes	
	5810	Intel	
	7045	Intersil	
	7047	Intersil	
	7200	Intersil	
	7202	Intersil	
	7203	Intersil	90
	7204	Intersil	
	7205	Intersil	
	7210	Intersil	
	7214	Intersil	
	TAC860	ITT	
	LMC6130	Litronix	
	7145	Micro Power	
	7155	Micro Power	
	7175	Micro Power	
	MK50440	Mostek	100
	MC14440	Motorola	
	MM58104	National	
	MM58115	National	
	MM58117	National	
	MM58118	National	
	MM58119	National	
	MM58120	National	
	MM5829	National	
	MM5860	National	
	MM58601	National	110
	MM5880	National	
	MM58801	National	
	MM5882	National	
	MM5885	National	
	MM5886	National	
	MM5890	National	
	5024	Nortec	
	MN6050	Panasonic	
	MN6051	Panasonic	
	MN6070	Panasonic	120
	MM6090	Panasonic	
	MS680	Ragen	
	MS681	Ragen	
	MS682	Ragen	
	MS683	Ragen	
	DF211	**Siliconix (601)**	
	SCL5430	SSS	
	(Cont'd)		

Consumer Circuits (Cont'd)

Function	Device	Source	Line
Watch (Continued) (Continued)			
	SY5001	Synertek	130
	SY5002	Synertek	
Watch, Stopwatch			
	MM5865	National	
	DF213	**Siliconix (601)**	
	DF214	**Siliconix (601)**	

† Military Temperature Range (−55°C to 125°C)

LINEAR—Followers

Bias Current na 25°C	Offset Voltage mv 25°C	Voltage Drift μv/°C	Unity Gain Bandwidth min	Slew Rate v/μs	Output v @ ma	Supply Range	Comments	Device	Source
Followers									
0.1	10	25*	100*	1000	9 @ 90	±5 to ±20	Fast Follower	LH0033	† National
0.15	20	25*	100*	1000	9 @ 90	±5 to ±20	Fast Follower	LH0033C	National
0.2	25	300*	200*	2000	10 @ 200	±5 to ±20	Very Fast Follower	LH0063	† National
	50	300*	200*	2000	10 @ 200	±5 to ±20	Very Fast Follower	LH0063C	National
1.0	10.0	—	—	4*	12@2	±5 to ±18	Follower	TCA410A	Signetics
2.0*	50	300*	300*	2000	10 @ 200	±5 to ±20	Gain 0.094 (50 ohm)	3553	† Burr-Brown
3	4.0	6*	12*	30*	10 @ 1	±5 to ±18	Follower, replaces 102	SG210	Silicon G
			20*	30*	10 @ 1	±5 to ±18	Follower, replaces 102	LM210	AMD
								MLM210	Motorola
								LM210	National
							Dual 210 Follower	LH2210	National
		10*	20*	30*	10 @ 1	±5 to ±18	Follower, replaces 102	110	† Intersil
								210	Intersil
		12*	12*	30*	10 @ 1	±5 to ±18	Follower, replaces 102	SG110	† Silicon G
			20*	30*	10 @ 1	±5 to ±18	Follower, replaces 102	LM110	† AMD
								μA110M	† Fairchild
								MLM110	† Motorola
								LM110	† National
							Dual 110 Follower	LH2110	† National
	10.0	—	—	4*	12@2	±5 to ±18	Follower	TCA410B/D	Signetics
7	7.5	10*	12*	30*	10 @ 1	±5 to ±18	Follower, replaces 102	SG310	Silicon G
			20*	30*	10 @ 1	±5 to ±18	Follower, replaces 102	LM310	AMD
								μA310C	Fairchild
								310	Intersil
								MLM310	Motorola
								LM310	National
							Dual 310 Follower	LH2310	National
10	5.0	6*	8*	10*	10 @ 1	±15	Follower	SG102	† Silicon G
			10*	10*	10 @ 1.25	±12 to ±18	Follower	LM102	† National
			—	—	10 @ 1.25	±15	Follower	μA102M	† Fairchild
								102	† Intersil
15	10.0	15*	8*	10*	10 @ 1	±15	Follower	SG202	Silicon G
			10*	10*	10 @ 1.25	±12 to ±18	Follower	LM202	National
			—	—	10 @ 1.25	±15	Follower	202	Intersil
30	15.0	20*	8*	10*	10 @ 1	±15	Follower	SG302	Silicon G
			10*	10*	10 @ 1.25	±12 to ±18	Follower	LM302	National
			—	—	10 @ 1.25	±15	Follower	μA302C	Fairchild
								302	Intersil

† Military Temperature Range (−55°C to 125°C) * Typical Values

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers

General Purpose

The 101A series consists of the 101A (-55°C to 125°C), the 201A (-25°C to 85°C) and the 301 (0°C to 70°C). These units require an external compensation capacitor which permits the bandwidth to be optimized for particular applications.

Function	Device	Source	Line
	LM101A	AMD	
	AD101A	**AD** (575)	
	μA101A	Fairchild	10
	101A	Intersil	
	MLM101A	Motorola	
	LM101A	National	
	CA101A	RCA	
	LM101A	Raytheon	
	SG101A	Silicon G	
	LM101A	Siliconix	
	LM101A	Teledyne S	
	LM101A	TI	
	TA7506	Toshiba	20

The performance of the 741 series is similar to the 101. These units include internal compensation to make the device stable and to eliminate the need for an external capacitor.

Function	Device	Source	Line
	741	AMD	
	AD741	**AD** (575)	
	μA741	Fairchild	
	HA17741	Hitachi	
	741	Intersil	
	ITT741	ITT	30
	MC1741	Motorola	
	LM741	National	
	SFC2741	NPC	
	PM741	PMI	
	SSS741	PMI	
	CA741	RCA	
	RC741	Raytheon	
	TBA221	Siemens	
	SG741	Silicon G	
	μA741	Signetics	40
	TL1741	Telefunken	
	μA741	TI	
	TA7504	Toshiba	

Dual Amplifiers. The 1458 (0D>C to 70D>C) and the 1558 (-55D>C to 125D>C) offer approximately the same performance as the 741. Compensation is built in.

Function	Device	Source	Line
	1458	AMD	
	XR1458	Exar	
	μA1458	Fairchild	50
	MC1458	Motorola	
	LM1458	National	
	PM1458	PMI	
	SSS1458	PMI	
	CA1458	RCA	
	RC1458	Raytheon	
	MC1458	Signetics	
	SG1458	Silicon G	
	1458	Teledyne S	
	MC1458	TI	60

FET Input. Bipolar/JFET available in standard (155), wideband (156) and uncompensated (157) versions, premium performance (A suffix), and various temperature ranges (155, 255, 355, etc)

Function	Device	Source	Line
	LF155	AMD	
	(Cont'd)		

General Purpose (Cont'd)

FET Input. Bipolar/JFET available in standard (155), wideband (156) and uncompensated (157) versions, premium performance (A suffix), and various temperature ranges (155, 255, 355, etc) (Continued)

Function	Device	Source	Line
	μAF155	Fairchild	70
	LF155	Intersil	
	LF155	Motorola	
	LF155	National	
	PM155	PMI	
	LF155	Raytheon	
	LF155	TI	

High Output Current

mA @ V	Device	Source	Line
2000 @ 30	3572A	Burr-Brown	80
1100 @ 11	833-21	Beckman	
	LH0021	† National	
1000 @ 30	3571A	Burr-Brown	
1000 @ 10	833-21C	Beckman	
	LH0021C	National	90
500 @ 10	LH0061	† National	
	LH0061C	National	
	LH0061	† TI	
	LH0061C	TI	
200 @ 10	μA759	† Fairchild	
	μA759C	Fairchild	
130 @ 13	LH0041	† National	100
	LH0041C	National	
100 @ 10	LH0003	National	
	825	Beckman	
100 @ —	CA3094	RCA	
75 @ 145	3583	Burr-Brown	
60 @ 30	3580J	Burr-Brown	110
50 @ 10	3554A	Burr-Brown	
	3554B	Burr-Brown	
	3554S	Burr-Brown	
	1430	Teledyne P	
50 @ 5	LH0005	National	
	LH0005A	† National	
47 @ 14	LH0020	† National	120
	LH0020C	National	
40 @ 4	LH0005C	National	
38 @ 11	CA3033A	† RCA	
	CA3047A	RCA	
30 @ 70	3581J	Burr-Brown	
30 @ 10	HFB7	DDC	130
	HVA23	DDC	
	HFS23	DDC	
22 @ 11	Q25AH	Teledyne P	

† Military Temperature Range (−55°C to 125°C)

LINEAR—Operational Amplifiers (Cont'd)

High Output Current (Cont'd)

ma @ v	Device	Source	Line
20 @ 12			
	TAA761	Siemens	
	TAA762	† Siemens	
	TAA765	Siemens	
	TCA315	Siemens	
	TCA325	Siemens	
20 @ 10			
	141410	Teledyne P	
20 @ 8			10
	TAA861	Siemens	
	TAA862	† Siemens	
18 @ 9			
	CA3033	† RCA	
15 @ 145			
	3582J	Burr-Brown	
15 @ 30			
	LH0004C	National	
15 @ 10			
	1018M	† DDC	20
	HA-2620	**† Harris (581)**	

High Speed

Unity Gain Slew Rate (v/μsec min)	Device	Source	Line
50			
	LM118	† AMD	
	LM318	AMD	
	AD518	**AD (574)**	
	AD518S	**† AD (574)**	
	AD528	**AD (574)**	
	AD528S	**† AD (574)**	
	1009M	† DDC	30
	μA118	† Fairchild	
	μA318	Fairchild	
	HA-2510	**† Harris (581)**	
	LH0062	† National	
	LH0062C	National	
	LM118	† National	
	LM318	National	
	SFC2118	† NPC	
	SFC2318	NPC	
	LM118	† Raytheon	40
	LM318	Raytheon	
	141410	Teledyne P	
	LM118	† TI	
	LM318	TI	
65			
	3550J	Burr-Brown	
	3550S	† Burr-Brown	
80			
	AD509J	**AD (574)**	
	3507J	Burr-Brown	50
	1322	† Teledyne P	
	132201	Teledyne P	
100			
	AD509K	**AD (574)**	
	AD509S	**† AD (574)**	
	3550K	Burr-Brown	
100 (g3)			
	HA-2520	**Harris (581)**	
120			
	AD505J	AD	60
	AD505K	AD	
	AD505S	† AD	
250			
	1010C	DDC	
	HA-2535	**Harris (580)**	
	LH0024C	National	
280			
	1010M	† DDC	
	HA-2530	**† Harris (581)**	
350			70
	LH0032	† National	
	LH0032C	National	
400			
	LH0024	† National	
500			
	1430	Teledyne P	
1000			
	825	† Beckman	

High Voltage

Maximum Supply Voltage	Device	Source	Line
±30			80
	MC1436C	Motorola	
	LM343	National	
	SG1436C	Silicon G	
±34			
	MC1436	Motorola	
	LM344	National	
	SG1436	Silicon G	
±35			
	3580J	Burr-Brown	
±40			90
	3571AM	† Burr-Brown	
	3572AM	† Burr-Brown	
	AM-464	Datel	
	HA-2640	† Harris	
	HA-2645	**Harris (580)**	
	MC1536	† Motorola	
	LH0004	† National	
	LH0004C	National	
	LM143	† National	
	LM243	National	100
	LM144	† National	
	SG1536	Silicon G	
	1332	Teledyne P	
±75			
	3581J	† Burr-Brown	
±150			
	3582J	† Burr-Brown	
	3583	Burr-Brown	
±225 (5v internal regulator)			
	ZN417	Ferranti	110
450 (5v internal regulator)			
	ZN417	Ferranti	

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers (Cont'd)

Low Bias Current

Rated values do not usually include thermal rise due to circuit operation.

Current @ 25°C	Device	Source	Line
0.01	ICH8500A	Intersil	
0.075	**AD515L**	**AD** (574)	
0.1	3523L	Burr-Brown	10
	ICH8500	Intersil	
0.15	**AD515K**	**AD** (574)	
0.25	3523K	Burr-Brown	
0.3	**AD515J**	**AD** (574)	
0.5	3523J	Burr-Brown	
	142901	Teledyne P	20
1.0	**AD523J**	**AD** (574)	
	3522L	Burr-Brown	
	1001M	† DDC	
	8007AC	Intersil	
	8007AM	† Intersil	
	LH0052	† National	
	1429	Teledyne P	
	1439	Teledyne P	
5.0	ADM501C	AD	30
	AD508L	**AD** (574)	
	AD523K	**AD** (574)	
	3522K	Burr-Brown	
	3522S	Burr-Brown	
	LH0052C	National	
	CA3080	RCA	
	CA3080A	† RCA	
	142501	Teledyne P	
	142502	Teledyne P	40

Low Drift

Voltage Drift (μV/°C Max)	Device	Source	Line
0.1	AM-490-2C	Datel	
0.3	AM-490-2B	Datel	
	HA-2904	**Harris** (580)	
0.5	**AD504M**	**AD** (575)	
	LH0044A	† National	
	LH0044AC	National	50
	LH0044B	National	
	OP-05A	PMI	
0.6	SS725A	† AMD	
	1012	† DDC	
	μA714A	† Fairchild	
	HA-2900	**† Harris** (581)	
	OP-05E	PMI	
	OP-07A	† PMI	
	SSS725A	† PMI	60
	SSS725E	PMI	
1.0	**AD504S**	**† AD** (575)	
	3500E	Burr-Brown	
	3521L	Burr-Brown	
	AM-490-2A	Datel	
	μA725A	† Fairchild	
	μA725E	Fairchild	
	LH0044	† National	
	LH0044C	National	70
	LM725A	National	
	SSS725	† PMI	
	SSS725B	PMI	
	OP-05	† PMI	
	142302	Teledyne P	
1.0 (Dual Unit)	OP-10	† PMI	
	OP-10A	† PMI	
	OP-10E	PMI	
	μA714	† Fairchild	80
	μA714E	Fairchild	
1.3	OP-07	† PMI	
	OP-07E	PMI	
1.5	OP-05C	PMI	
	SSS725C	PMI	
1.5 (Dual Unit)	OP-10C	PMI	
	μA714C	Fairchild	90
1.6	OP-07C	PMI	
2.0	142301	Teledyne P	

Programmable

Function	Device	Source	Line
Adjustable Current/Performance			
Single (1 unit per package)	1003C	DDC	
	1003M	† DDC	
	μA776C	Fairchild	100
	μA776M	† Fairchild	
	HA-2720	**† Harris** (581)	
	HA-2725	**Harris** (580)	
	4250	Intersil	
	4250C	Intersil	
	8021C	Intersil	
	8021M	† Intersil	
	MC1776	† Motorola	
	MC1776C	Motorola	
	MC3476	Motorola	110
	LM4250	† National	
	LM4250C	National	
	CA3078	RCA	
	CA3078A	† RCA	
	CA3080	RCA	
	CA3080A	† RCA	
	CA3094	† RCA	
	CA3094A	† RCA	
	CA3094B	† RCA	
	SG1250	† Silicon G	120
	SG2250	Silicon G	
	SG3250	Silicon G	
	SG4250	† Silicon G	
	SG4250C	Silicon G	
Dual (2 units per package)	**HA-2730**	**† Harris** (581)	
	HA-2735	**Harris** (580)	
	8022C	Intersil	
	8022M	† Intersil	
	LH24250	† National	130
	LH24250C	National	
Triple (3 units per package)	8023C	Intersil	
	8023M	† Intersil	
	CA3060	RCA	
	CA3060	† RCA	
	CA3060A	RCA	
	CA3060B	RCA	
	L144A	**† Siliconix** (604)	
	L144B	**Siliconix** (604)	140
	L144C	**Siliconix** (604)	
Quad (4 units per package)	XR4202	Exar	

† Military Temperature Range (−55°C to 125°C)

LINEAR—Operational Amplifiers (Cont'd)

Single Supply

Supply Voltage	Device	Source	Line
Single (1 unit per package)			
5 to 16			
	CA3130	† RCA	
	CA3130A	† RCA	
	CA3130B	† RCA	
to 24			
	CA3094	† RCA	
to 36			
	μA759	† Fairchild	10
	μA759C	Fairchild	
	CA3140	RCA	
	CA3094A	† RCA	
to 44			
	CA3140B	† RCA	
	CA3094B	† RCA	
Dual (2 units per package)			
3 to 26			
	LM2904	National	
3 to 30			20
	MLM158	† Motorola	
	MLM258	Motorola	
	MLM358	Motorola	
	LM158	† National	
	LM258	National	
	LM358	National	
	LM158A	† National	
	LM258A	National	
	LM358A	National	
	NE532	† Signetics	30
	SE532	Signetics	
	LM158	† TI	
	LM258	TI	
	LM358	TI	
3 to 36			
	μA798	Fairchild	
	MC3458	Motorola	
8 to 36			
	TBA231	SGS	
Quad (4 units per package)			40
4 to 18			
	μA3401C	Fairchild	
	LM3401	National	
	MC3401	Motorola	
	CA3401	† RCA	
	RC3401	Raytheon	
3 to 26			
	MLM2902	Motorola	
	LM2902	National	
4 to 28			50
	μA3301C	Fairchild	
	MC3301	Motorola	
	LM3301	National	
	RC3301	Raytheon	
3 to 30			
	LM124	† AMD	
	LM224	AMD	
	LM324	AMD	
	XR124	† Exar	

(Cont'd)

Single Supply (Cont'd)

Supply Voltage	Device	Source	Line
3 to 30 (Continued)			60
	XR224	Exar	
	XR324	Exar	
	μA124	† Fairchild	
	μA224	Fairchild	
	μA324	Fairchild	
	LM124	† Intersil	
	LM224	Intersil	
	LM324	Intersil	
	MLM324	Motorola	70
	LM124	† National	
	LM224	National	
	LM324	National	
	CA124	† RCA	
	CA224	RCA	
	CA324	RCA	
	LM124	† Raytheon	
	LM224	Raytheon	
	LM324	Raytheon	
	LM124	† Signetics	80
	LM224	Signetics	
	LM324	Signetics	
	SG124	† Silicon G	
	SG224	Silicon G	
	SG324	Silicon G	
	LM124	† TI	
	LM224	TI	
	LM324	TI	
3 to 32			
	MLM2902	Motorola	90
	LM2902	Raytheon	
	RC4137	Raytheon	
	RM4137	† Raytheon	
	RV4137	Raytheon	
4 to 32			
	LM2900	National	
	LM3900	National	
3 to 36			
	XR3303	Exar	
	XR3403	Exar	100
	XR3503	† Exar	
	μA3303C	Fairchild	
	μA3403C	Fairchild	
	μA3503M	† Fairchild	
	MC3303	Motorola	
	MC3403	Motorola	
	MC3503	† Motorola	
	RC3403	**Raytheon (586)**	
	RM3403	**Raytheon (586)**	
	RM3503	**† Raytheon (586)**	110
	RV3403	**Raytheon (586)**	
4 to 36			
	LM1900	National	
	LM2900	Raytheon	
	LM3900	Raytheon	

Wide Band

Unity Gain Bandwidth MHz	Device	Source	Line
30*			
	μA702C	Fairchild	
	μA702M	† Fairchild	
	MC1712	Motorola	120
	LH0003	† National	
	LH0003C	National	
	LH0005	† National	
	LH0005A	National	
	LH0005C	† National	
	SL702C	Plessey	
	RC702	Raytheon	
	RM702	† Raytheon	
	TL702M	† TI	
	TL702C	TI	130
	μA702M	† TI	
30			
	Q25AH	† Teledyne P	
35			
	825	† Beckman	
35*			
	AD507J	**AD (574)**	
	AD507K	**AD (574)**	
	AD507S	**† AD (574)**	
38*			140
	CA3100	† RCA	
50			
	HFS23	DDC	
50*			
	3551J	Burr-Brown	
	3551S	† Burr-Brown	
	CA3015	† RCA	
	CA3015A	† RCA	
	CA3016	† RCA	
	CA3016A	† RCA	150
	CA3030	RCA	
	CA3030A	RCA	
	CA3038	† RCA	
	CA3038A	† RCA	
60*			
	1430	Teledyne P	
65*			
	μA715C	Fairchild	
	μA715M	† Fairchild	
70*			160
	LH0024	† National	
	LH0024C	National	
	LH0032	† National	
	LH0032C	National	
100			
	HFB7	DDC	
	HVA23	DDC	

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers-Characteristics

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Single-Unit Package											
0.025	2	2	0.6	1.2*	0.25*	300K	110	0	Ultra Low Offset Voltage. Low Drift	μA714A OP-07A	† Fairchild † PMI
	10	2.5	2	0.3*	0.1*	1M	110	0	Trimmed Offset	**AD510L** **AD510S**	**AD (575)** **† AD (575)**
	15	2.5	0.5	0.4*	0.06*	1M	120	1	Precision, Low Noise	LH0044A LH0044AC	† National National
0.05	0.050	0.0005*	75*	1*	6*	20K	70	0	FET	3540J	† Burr-Brown
	0.5	0.3	0.2*	3*	10*	100K	80	3	Chopper Stabilized	TL089I	TI
	1	0.5	0.4	3*	2.5*	10M	130	3	Chopper Stabilized	**HA-2904**	**Harris (580)**
	13	4.0	1	0.3	0.1*	1M	110	0	Trimmed Offset	**AD510K**	**AD (575)**
	30	5	0.5	0.4*	0.06*	500K	114	1	Precision, Low Noise	LH0044B	National
			1	0.4*	0.06*	500K	114	1	Precision, Low Noise	LH0044	† National
0.06	1	0.5	0.6	3*	2.5*	1M	120	3	Chopper Stabilized	1012M **HA-2900**	† DDC **† Harris (581)**
0.075	3	2.8	1.3	1.2*	0.25*	200K	110	0	Ultra Low Offset Voltage, Low Drift	μA714 OP-07	† Fairchild † PMI
	4	3.8	1.3	1.2*	0.25*	200K	106	0	Ultra Low Offset Voltage, Low Drift	μA714E OP-07E	Fairchild PMI
0.08	1	0.5	0.2*	3*	2.5*	1M	120	3	Chopper Stablilized	AM-490 1012C **HA-2905** 1340	Datel DDC **Harris (580)** Teledyne P
0.10	10	5	0.5	0.3*	0.1*	1-1000	80	0	Instrumentation	**AD522C**	**AD (578)**
	25	5	3	3*	0.1*	250K	94	0	Trimmed Offset	**AD510J**	**AD (575)**
	35	5	1	0.4*	0.06*	500K	114	1	Precision, Low Noise	LH0044C	National
	70	1	0.6	—	—	1M	120	4	Instrumentation	SSS725A	† PMI
			0.8	—	—	1M	120	4	High Performance 725	SSS725A	† AMD
0.15	1	0.6	0.2*	3*	10*	100K	100	3	Chopper Stabilized	TL089C	TI
	2	2	0.9	1.2*	0.25*	300K	114	0	Instrumentation	OP-05A	† PMI
	7	6	1.8	1.2*	0.25*	120K	100	0	Ultra Low Offset Voltage, Low Drift	μA714C OP-07C	Fairchild PMI
0.20	15	10	2	0.3*	0.1*	1-1000	80	0	Instrumentation	**AD522B**	**AD (578)**
	25	20	6	0.3*	0.1*	1-1000	75	0	Instrumentation	**AD522S**	**† AD (578)**
0.25	0.010	0.002*	1	1.5*	0.6	100K	90*	0	Ultra Low Drift FET	3521L	Burr-Brown
	0.015	0.002*	2	1.5*	0.6	100K	90*	0	Ultra Low Drift FET	3521K	Burr-Brown
	0.020	0.020*	5	1.5*	0.6	50K	90*	0	Ultra Low Drift FET	3521J 3521R	Burr-Brown † Burr-Brown
0.40	25	20	6	0.3*	0.1*	1-1000	75	0	Instrumentation	**AD522A**	**AD (578)**
0.5	0.0001	0.00005	25	1*	0.6	100K	80*	0	Ultra Low Bias FET	3523L	Burr-Brown
	0.00025	0.0001	25	1*	0.6	100K	80*	0	Ultra Low Bias FET	3523K	Burr-Brown
	0.001	0.0001	5	1*	1.5	100K	80	0	Precision FET	LH0052	† National
	0.005	0.001*	25	1*	0.6	50K	90*	0	Low Offset FET	3522K 3522S	Burr-Brown Burr-Brown

† Military Temperature Range (−55°C to 125°C)

"Comp" indicates number of compensation components required.

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Single-Unit Package (Cont'd)											
0.05	0.020	0.002*	10	1.5*	0.6	50K	90*	0	Ultra Low Drift FET	3521H	Burr-Brown
	0.025	0.01*	25	6	20	100K	80	0	Fast Settling, FET	142701	Teledyne P
	0.010	—	5	800*	1000*	200K	60*	1	150ns Settling	3554B	Burr-Brown
	2	0.2	5	1*	0.3*	80K	96	1	Precision Bipolar, Low Bias	LM108A	† AMD
										LM208A	AMD
										AD108A	**† AD (575)**
										AD208A	**AD (575)**
										μA108AM	† Fairchild
										μA208AM	Fairchild
										108A	† Intersil
										208A	Intersil
										MLM108A	† Motorola
										MLM208A	Motorola
										LM108A	† National
										LM208A	National
										SFC2108A	† NPC
										SFC2208A	NPC
										PM108A	† PMI
										PM208A	PMI
										LM108A	† Raytheon
										LM208A	† Raytheon
										CA108A	† RCA
										CA208A	RCA
										LM108A	† Signetics
										LM208A	Signetics
										SG108A	† Silicon G
										SG208A	Silicon G
				0.3*	0.1	80K	96	0	Compensated 108A	SG1118A	† Silicon G
										SG2118A	Silicon G
	3	2.8	2	1.2*	0.25*	200K	114	0	Instrumentation	OP-05	† PMI
	4	3.8	2	1.2*	0.25*	200K	110	0	Instrumentation	OP-05E	PMI
	7	1	5	1*	0.3*	80K	96	1	Precision Bipolar	LM308A	AMD
										AD308A	**AD (575)**
										μA308AC	Fairchild
										308A	Intersil
										MLM308A	Motorola
										LM308A	National
										PM308A	PMI
										CA308A	RCA
										LM308A	Raytheon
										LM308A	Signetics
										SG308A	Silicon G
				0.3*	0.1	80K	96	0	Compensated 308A	SG3118A	Silicon G
	30	5	5	1*	0.25*	80K	90	1	General Purpose	**AD301AL**	**AD (575)**
	35	2	8	0.8	0.25	100K	90	0	General Purpose	OP-02A	† PMI
										OP-02E	PMI
	50	5	5	1*	0.5*	50K	90	0	Higher Accuracy 741	**AD741L**	**AD (575)**
		30	1	1.5*	0.8	100K*	100*	0	Low Drift	3500E	Burr-Brown
	75	5	2	1	0.005*	1000K	110	4	High Accuracy Instrumentation	μA725AM	† Fairchild
0.7	30	2	5	2.5*	18*	50K	90	0	High Speed	OP-01	† PMI
										OP-01H	PMI
0.75	80	5	1	—	—	1000K	110	4	Instrumentation	SSS725B	PMI

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Single-Unit Package (Cont'd)											
0.75	80	5	2.8*	—	—	1000K	110	4	High Performance 725	SSS725B	AMD
			—	1*	0.3*	50K	80	0	High Performance	µA741AM	† Fairchild
				0.44	0.3	50K	80	0	High Performance	µA741EC	Fairchild
1.0	0.000075	—	25	0.35	0.3	50K	70	0	FET Electrometer	**AD515L**	**AD (574)**
	0.00015	—	15	0.35	0.3	100K	80	0	FET Electrometer	**AD515K**	**AD (574)**
	0.0005	0.0001*	30	0.5	3	40K	80		Ultra Low Bias FET	142901	Teledyne P
		0.0002	50	1*	0.6	100K	80*	0	Ultra Low Bias FET	3523J	Burr-Brown
	0.005	0.0002	10	1*	1	75K	76	0	Precision FET	LH0052C	National
		0.002	25	4*	3	25K	80*	0	General Purpose FET	ADM501C	AD
				1	3	50K	70		Low Bias Current, FET	142501	Teledyne P
		0.002*	10	1	3	50K	70			142502	Teledyne P
		—	10	1*	3	75K	80	0	High Accuracy, FET	**AD506L**	**AD (574)**
	0.010	0.002*	50	1*	0.6	50K	90*	0	Low Offset FET	3522J	Burr-Brown
		0.005*	25	1	3	50K	70		Low Drift, FET	142601	Teledyne P
				10*	65	25K	70*	0	Fast Settling, 1 µs to 0.01%	3550J 3550S	Burr-Brown † Burr-Brown
				20*	100	25K	70*	0	Fast Settling, 0.6 µs to 0.01%	3550K	Burr-Brown
		—	25	4*	3	25K	80*	0	General Purpose FET	ADM501B	AD
	0.015	—	25	10*	50	50K	80	0	Fast Wideband, High Accuracy	**AD528K** **AD528S**	**AD (574)** **† AD (574)**
	0.025	0.01*	5	1	3	50K	70	0	Low Drift, FET	142603	Teledyne P
			10	1	3	50K	70	0	Low Drift, FET	142602	Teledyne P
	0.030	0.01*	10	1	3	10K	76	0	Battery, FET Micropower	140202	Teledyne P
	0.050	0.01*	50	6	20	100K	80	0	Fast Settling, FET	1427	Teledyne P
		—	25	800*	1000*	2005	60*	1	150ns Settling	3554S	† Burr-Brown
	0.10	0.01	50	50*	250*	100K	70*	1	Wideband, Fast Settling	3551J 3551S	Burr-Brown † Burr-Brown
		—	25	800*	1000*	200K	60	1	150 ns settling	3554A	Burr-Brown
	15	7*	3	1.5*	1	45K	100*	0	Low Bias, Low Noise	3500C	Burr-Brown
			5	1.5*	1	45K	100*	0	Low Bias, Low Noise	3500T	† Burr-Brown
		7	—	—	1.5*	50K	—	0	Low Input Bias, High Slew Rate	ULS-2171	† Sprague
	35	7	10	0.1	0.12	25K	94	0	Micropower	140411	Teledyne P
	100	20	4*	1*	0.25*	25K	70	2	General Purpose Low Quiescent Power	LH0001	† National
						30K	70	2	High Voltage	LH0004	† National
			5	1*	0.005*	1000K	110	4	High Accuracy Instrumentation	µA725M LM725	† Fairchild † National
				0.5*	0.01*	1000K	110	4	Instrumentation	RM725	† Raytheon
				—	—	1000K	110	4	Instrumentation	725 PM725	† AMD † PMI
	200	50	6	1*	0.4*	25K	80	3	General Purpose	RM709A	† Raytheon

† Military Temperature Range (−55°C to 125°C)

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source	
Single-Unit Package (Cont'd)												
1.3	7	6	4.5	1.2*	0.25*	120K	100	0	Instrumentation	OP-05C	PMI	
	110	13	1.5	—	—	500K	100	4	Instrumentation	SSS725C	PMI	
1.5	0.010	—	25	1*	3	50K	80	0	High Accuracy, FET	**AD506K**	**AD**	**(574)**
			50	1*	3	50K	80	0	High Accuracy, FET	**AD506S**	**† AD**	**(574)**
	0.020	—	25	1*	50*	50K	80	1-3	High Speed, Laser Trim	AD516K	AD	
			50	1*	50*	50K	80	1-3	High Speed, Laser Trim	AD516S	† AD	
	80	5	0.6	—	—	1000K	120	4	Instrumentation	SSS725E	PMI	
			1	—	—	1000K	120	4	Instrumentation	SSS725	† PMI	
			2	—	—	1000K	120	4	High Performance 725	SSS725	† AMD	10
				0.5*	0.005*	1000K	120	4	Instrumentation	LM725A	† National	
			2*	—	—	1000K	120	4	High Performance 725	SSS725E	AMD	
		10	0.5	0.3*	0.12*	1000K	110	1	Low Drift, Low Noise	**AD504M**	**AD**	**(575)**
			1	0.3*	0.12*	1000K	110	1	Low Drift, Low Noise	**AD504L**	**AD**	**(575)**
							110	1	Ultra Stable	**AD504S**	**† AD**	**(575)**
	100	15	3	0.3*	0.12*	500K	100	1	Low Drift, Low Noise	**AD504K**	**AD**	**(575)**
		20	10	—	—	500K	100	4	Instrumentation	725B	AMD	
	120	45	4*	1*	0.25*	30K	70	2	High Voltage	LH0004C	National	
2.0	0.010	0.0005*	5	1*	6*	20K	70	0	Highest Performance, see 1001C665	1001C113	DDC	20
					3	50K	70	0	Low Offset Voltage, FET	8007C-1	Intersil	
			15	1*	6*	50K	70	0	Highest Performance, see 1001M664	1001M313	† DDC	
					3	50K	70	0	Low Offset Voltage, FET	8007C-2	Intersil	
										8007M-2	† Intersil	
		0.005*	50	1	3	50K	70	—	Low Bias Current, FET	1425	Teledyne P	
		—	75	4*	3	25K	80*	0	General Purpose FET	ADM501A	AD	
	0.020	0.010	15	4*	10*	50K	86	1	CMOS, Single Supply, Strobe	CA3130B	† RCA	
	0.025	0.01*	50	1	3	100K	72		Low Drift, FET	1426	Teledyne P	30
	0.030	0.01	—	4.5*	9*	50K	86	0	MOS FET, Single Supply	CA3140B	† RCA	
	0.050	0.01	5	2.5*	3	50K	85	0	Bipolar - JFET	µAF155A	† Fairchild	
										µAF355A	Fairchild	
										LF155A	† Motorola	
										LF355A	Motorola	
										PM155A	† PMI	
										PM355A	PMI	
										LF155A	† National	
										LF355A	National	
										LF155A	† TI	40
										LF355A	TI	
				4	10	50K	85	0	Wideband - JFET	µAF156A	† Fairchild	
										µAF356A	Fairchild	
										LF156A	† Motorola	
										LF356A	Motorola	
										PM156A	† PMI	
										PM356A	PMI	
										LF156A	† National	
										LF356A	National	
										LF156A	† TI	50
										LF356A	TI	

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Single-Unit Package (Cont'd)											
2.0	0.050	0.01	4	—	—	50K	85	1	Wideband Uncompensated	μAF157A	† Fairchild
										μAF357A	Fairchild
										LF157A	† Motorola
										LF357A	Motorola
										PM157A	† PMI
										PM357A	PMI
										LF157A	† National
										LF357A	National
										LF157A	† TI
										LF357A	TI
	0.10	0.05*	40	0.5*	3	50K	80	1	High Current, High Power	3571A	Burr-Brown
							80	1	High Current, High Power	3572A	Burr-Brown
	0.50	—	75	60*	500	200K	—	0	Inverting, Settles 0.01% in 200 ns	1430	Teledyne P
										1430	Teledyne P
	2	0.2	15	1*	0.2*	50K	85	0	Micropower, Supply Current 600 μa	LM112	† AMD
										LM212	AMD
										LM112	† National
										LM212	National
										LM112	† Raytheon
										LM212	Raytheon
					0.1*	50K	85	0	Compensated 108/208	SG1118	† Silicon G
										SG2118	Silicon G
					0.3*	50K	85	1	Precision Bipolar	LM108	† AMD
										LM208	AMD
										AD108	**† AD (575)**
										AD208	**AD (575)**
										μA108M	† Fairchild
										μA208M	Fairchild
										108	† Intersil
										208	Intersil
										MLM108	† Motorola
										MLM208	Motorola
										LM108	† National
										LM208	National
										SFC2108	† NPC
										SFC2208	NPC
										PM108	† PMI
										PM208	PMI
										CA108	† RCA
										CA208	RCA
										LM108	† Raytheon
										LM208	Raytheon
										LM108	† Signetics
										LM208	Signetics
										SG108	† Silicon G
										SG208	Silicon G
				0.3*	0.3*	50K	85	1	Low Noise 108	108LN	† Intersil
	3	2	10	0.5*	0.1	45K	100*	0	Low Bias Current	3501C	Burr-Brown
	5.0	0.5	10	—	1.7*	2.5K	80	3	Wideband	μA702M	† TI
	7	3	10	0.5*	0.1	45K	100*	0	Low Bias Current	3501B	Burr-Brown
										3501S	† Burr-Brown
	15	5	3	3	1.5	40K	80	0	High Performance, High Gain	MC1556	† Motorola
										RM1556A	† Raytheon

† Military Temperature Range (−55°C to 125°C)

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Single-Unit Package (Cont'd)											
2.0	20	10*	5	1.5*	1	45K	100*	0	Low Bias, Low Noise	3500B	Burr-Brown
			10	1.5*	1	45K	100*	0	Low Bias, Low Noise	3500S	† Burr-Brown
	25	3	15	0.5	0.5*	50K	80	1	Low Offset Current	µA777M	† Fairchild
										SG777	† Silicon G
										µA777M	† TI
	35	5	15	—	1.0	100K	80	0	Improved 107	844B	† Teledyne S
							80	1	Improved 101A	846B	† Teledyne S
	50	5	8	2.5*	18*	50K	80	0	High Speed	OP-01E	PMI
										OP-01F	† PMI
			10	0.8	0.25	50K	90	0	General Purpose	OP-02	† PMI
										OP-02C	PMI
			15	1*	0.4	50K	80	0	High Performance, Low Drift	131901	† Teledyne P
			—	—	—	100K	80	0	High Performance 741	SSS741	† AMD
										SSS741	† PMI
					0.6*	50K	—	0	General Purpose	ULS-2151	† Sprague
		10	15	4*	1.5	25K	80	0	High Performance, High Gain	RM4131	† Raytheon
		50	25	1*	0.4	50K	80	0	High Performance, Low Drift	1319	Teledyne P
	60	10	15	—	10	50K	70	0	High Slew Rate	SE535	† Signetics
	75	10	15	1*	0.5*	50K	80	0	General Purpose, Compensated	LM107	† AMD
										LM207	AMD
										µA107M	† Fairchild
										µA207M	Fairchild
										107	† Intersil
										207	Intersil
										MLM107	† Motorola
										MLM207	Motorola
										LM107	† National
										LM207	National
										SFC2107	† NPC
										SFC2207	NPC
										LM107	† Raytheon
										LM207	Raytheon
										CA107	† RCA
										CA207	RCA
										LM107	† Signetics
										LM207	Signetics
										SG107	† Silicon G
										SG207	Silicon G
										LM107	† TI
										LM207	TI
							80	0	Higher Accuracy 741	**AD741S**	**AD** **(575)**
										7411C	Intersil
							90	0	Higher Accuracy 741C	**AD741K**	**† AD** **(575)**
							80	1	General Purpose, Improved 101, Uncompensated	LM101A	† AMD
										LM201A	AMD
										AD101A	**† AD** **(575)**
										AD201A	**AD** **(575)**
										µA101AM	† Fairchild
										µA201AM	Fairchild

(Cont'd)

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Single-Unit Package (Cont'd)											
2.0	75	10	15	1*	0.5*	50K	80	1		(Continued)	
										101A	† Intersil
										201A	Intersil
										MLM101A	† Motorola
										MLM201A	Motorola
										LM101A	† National
										LM201A	National
										LM101A	† Raytheon
										LM201A	Raytheon
										CA101A	† RCA
										CA201A	RCA
										LM101A	† Signetics
										LM201A	Signetics
										SG101A	† Silicon G
										SG201A	Silicon G
										LM101A	† Teledyne S
										LM201A	Teledyne S
										LM101A	† TI
										LM201A	TI
				0.8*	0.5*	50K	80	1	Low Noise 101A	101ALN	† Intersil
		30	—	—	1	50K	70	0	Improved 307	844C	Teledyne S
							70	1	Improved 301A	846C	Teledyne S
		—	15*	4*	120	100K	—	0	High Speed Inverting	AD505J	AD
	200	50	10	5*	0.3*	25K	80	3	General Purpose	µA709AM	† Fairchild
										ITT709-A	† ITT
										MC1709A	† Motorola
										LM709A	† National
										SFC2709A	† NPC
										µA709A	† Signetics
										µA709AM	† TI
	4000	1500	1.2*	15*	3*	0.7K	70	1	6 Volt, Wideband	CA3008A	RCA
										CA3010A	† RCA
										CA3029A	RCA
										CA3037A	† RCA
	5000	500	2.5*	7*	1.5*	2.5K	80	2	Wideband	MC1712	† Motorola
			10	30*	3.5*	2.5K	80	3	Wideband	µA702M	† Fairchild
										RM702	† Raytheon
										µA702M	† TI
	6000	1600	1.2*	50*	7*	2K	80	1	12 Volt, Wideband	CA3015A	† RCA
										CA3016A	† RCA
										CA3030A	RCA
										CA3038A	† RCA
2.5	25	5	3	0.3*	0.12*	250K	94	1	Chopperless, Low Drift	**AD506J**	**AD** (575)
		—	15*	4*	120	200K	—	0	High Speed Inverting	AD505K	AD
										AD505S	† AD
	100	20	3*	1*	0.25*	25K	70	2	Micropower, High Performance	LH0001A	† National
			2*	1*	0.005*	250K	94	4		725C	AMD
										µA725C	Fairchild
										LM725C	National
										PM725C	PMI
										RC725	Raytheon
	200	40	5.0	0.3*	0.12*	250K	94	1	Low Drift, Low Noise	**AD504J**	**AD** (575)
	250	50	10*	1*	0.25*	100K	90	2	High Gain Instrumentation, 50 ma	LH0020	† National

† Military Temperature Range (−55°C to 125°C)

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source	
Single-Unit Package (Cont'd)												
3.0	0.0003	—	50	0.35	0.3	40K	66	0	FET Electrometer	**AD515J**	**AD**	**(574)**
	0.020	0.020*	25	5	20*	50K	110*	0	High Voltage FET	3581J	Burr-Brown	
				3*	20*	100K	110*	0	High Voltage FET	3582J	Burr-Brown	
				5*	20*	400K	110*	0	High Voltage FET	3583	Burr-Brown	
	0.030	0.1*	50	1	3	10K	76	0	Battery, FET Micropower	1402	Teledyne P	
		—	50	10*	50	25K	70	0	Fast Wideband, High Accuracy	**AD528J**	**AD**	**(574)**
	0.050	0.015	—	1*	0.3*	40K	80	0	High Performance, Low Input Current	LM216A	AMD	
										LM316A	AMD	
										LM216A	National	
										LM316A	National	
										LM216A	Raytheon	
										LM316A	Raytheon	
	0.10	—	75	35	1000	25K	72	0	Fast Settling	825	† Beckman	
	4	0.5	5	100	1000	1000K	0		Fast Settling	AM-500	Datel	
	5	3	10*	—	0.1*	40K	80	0	Programmable Amplifier	**HA-2720**	**† Harris**	**(581)**
	7.5	3	—	.25*	0.16*	100K	70	0	Programmable	4250	† Intersil	
										LM4250	† National	
										SG4250	† Silicon G	
										UC4250	† Solitron	
	10	2	15	0.3*	0.13*	50K	80	0	Micropower	RM4132	† Raytheon	
				12*	4	100K	80	0	High Impedance	**HA-2600**	**† Harris**	**(581)**
	12	5	4*	—	0.2*	100K	70	0	Programmable	SG1250	† Silicon G	
										SG2250	Silicon G	
	15	15	15	35*	25	100K	80	1	Wideband, General Purpose	**AD507K**	**AD**	**(574)**
	20	2.5*	30*	1*	10	200K	80	0	Micropower, High Output Current	132301	Teledyne P	
				8	25	100K	80	4	Micropower, High Output Current	132302	† Teledyne P	
		7.5	5*	0.27*	0.16*	50K	70	0	Low Power Adjustable Current	1003M	† DDC	
										8021M	† Intersil	
		10	5*	1*	10	400K	86	0	Wide Response, Low Power	1011M	† DDC	
										HA-2700	**† Harris**	**(581)**
										HA-2704	**Harris**	**(580)**
	25	5	10*	—	—	4K	60	3	Matched Transistors	LH0005A	† National	
	50	5	—	—	—	50K	80	0	Higher Performance	SSS741B	PMI	
	80	30	15	0.4	0.3	50K	80	0	Higher Performance	LM741A	† National	
										LM741E	National	
	100	20	5*	—	280	100K	86	1	High Slew Rate Inverting	1010M	† DDC	
										HA-2530	**† Harris**	**(581)**
		30	—	1*	0.6	50K	80	0	to 500 ma, single supply	µA759	† Fairchild	
	200	50	20	1*	0.5*	50K	80	0	Higher Accuracy 741C	**AD741J**	**AD**	**(575)**
							80	0	High Current	AD512K	AD	
			25	1*	0.5*	50K	80	0	High Current	AD512S	† AD	
	300	100	—	2*	1	25K	70	1	-1 amp	833-21	† Beckman	

† Military Temperature Range (−55°C to 125°C)

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LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Single-Unit Package (Cont'd)											
3.0	300	100	3*	1*	1.5*	100K	70	1	0.2 amp Power	LH0041	† National
			10	1*	0.4*	25K	70	3	High Gain	RM709	† Raytheon
			25	1*	1.5	100K	70	1	1.0 amp Power	LH0021	† National
	400	30*	5	1*	1.2	45K	90*	1	General Purpose	3051	Burr-Brown
										3055	Burr-Brown
	500	60	5*	1*	34*	50K	80	3	Fast General Purpose	133902	† Teledyne P
			—	—	4.2*	15K		2	High Slew Rate	ULS-2139	† Sprague
		75	3*	2*	4.2*	50K	80	2	General Purpose	MC1539	† Motorola
	2000	200	4*	10*	—	20K	70	0	General Purpose Wide Bandwidth	LH0003	† National
										LH0003C	National
3.5	0.015	—	75	1*	3	20K	70	0	High Accuracy, FET	**AD506J**	**AD** (574)
	0.030	—	75	1*	50*	20K	70	1-3	High Speed, Laser Trim	AD516J	AD
		0.02	10*	4*	10*	320K*	80	1	CMOS, Single Supply, Strobe	CA3130A	† RCA
	12	2.5	6*	—	0.04*	40K	80	1	Micropower	CA3078A	† RCA
							80	1	Low Noise, Micropower	CA6078A	† RCA
4.0	0.010	0.002	10	1*	1.5	100K	80	0	High Performance FET	LH0022	† National
	0.020	0.0005*	30	1*	3	50K	70	0	FET Input	8007C-3	Intersil
	10	10	5*	12*	4	100K	80	0	High Impedance	1008M	† DDC
	15	2	15	4*	2*	40K	80	0	High Performance, High Gain	RM1556	† Raytheon
			—	1*	2.5*	100K	80	0	High Performance	MC1556	† Motorola
										MC1556	Signetics
										SG1556	† Silicon G
		15	10*	35*	25	100K	80	1	Wide Band, High Impedance	1018M	† DDC
										HA-2620	**† Harris** (581)
			20	35*	20	100K	80	1	Wideband, General Purpose	**AD507S**	**† AD** (574)
	25	12	15*	4*	5*	100K	80	0	High Voltage	HA-2640	† Harris
	200	50	15	12*	10	50K	80	0	High Speed, Fast Settling	**AD518K**	**AD** (574)
			20	12*	10	50K	80	0	High Speed, Fast Settling	**AD518S**	**† AD** (574)
	250	50	—	15*	50	50K	80	0	Precision High Speed	LM118	† AMD
										LM218	AMD
										µA118	† Fairchild
										µA218	Fairchild
										LM118	† National
										LM218	National
										SFC2118	† NPC
										SFC2218	NPC
										LM118	† Raytheon
										LM218	Raytheon
										LM118	† TI
										LM218	TI
	300	100	5*	1*	25	50K	70	1	0.5a, wideband	LH0061	† National
										LH0061	† TI
	350	100	3*	1*	0.5	50K	80	0	741 type	TBA222	† Siemens
	500	40*	10	0.9*	0.9	45K	90*	1	General Purpose	3056	Burr-Brown
				1.0*	1.2	45K	90*	1	General Purpose	3052	Burr-Brown

† Military Temperature Range (−55°C to 125°C)

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Single-Unit Package (Cont'd)											
4.0	30000	5000	20*	70*	400	4K	60*	3	High Slew Rate	LH0024	† National
4.5	170	32	6*	—	0.04*	25K	80	1	Micropower	CA3078	RCA
5.0	0.001	0.0003*	90	0.5	3	20K	70		Ultra Low Bias FET	1429	Teledyne P
		0.0005*	25	1*	0.6	50K	90*	0	Low Offset FET	3522L	Burr-Brown
	0.005	0.0006		2*	50*	—	80	0	Micropower, Transconductance Amplifier	CA3080	RCA
										CA3080A	† RCA
	0.025	0.002	25	15*	50	50K	80	0	Precision, High Speed, FET	LH0062	† National
	0.040	0.02	—	4.5*	9*	20K	70	0	MOS FET Single Supply	CA3140A	RCA
	0.050	0.025	55	—	—	37K	60	0	FET Input 741	2740B	Teledyne S
	0.10	0.02	5*	2.5*	5*	50K	85	0	Bipolar - JFET	LF155	† AMD
										LF255	AMD
										μAF155	† Fairchild
										LF155	† Intersil
										LF155	† National
										LF255	National
										PM155	† PMI
										PM255	PMI
										LF155	† Raytheon
										LF255	Raytheon
										LF155	† TI
										LF255	TI
				7.5*	15*	50K	85	0	Wideband - JFET	LF155	† AMD
										LF256	AMD
										LF156	† Intersil
										μAF156	† Fairchild
										LF156	† National
										LF256	National
										PM156	† PMI
										PM256	PMI
										LF156	† Raytheon
										LF256	Raytheon
										LF156	† TI
										LF256	TI
				—	—	50K	85	1	Wideband Uncompensated	LF157	† AMD
										LF257	AMD
										LF157	† Intersil
										μAF157	† Fairchild
										LF157	† National
										LF257	National
										PM157	† PMI
										LM257	PMI
										LF157	† Raytheon
										LF257	Raytheon
										LF157	† TI
										LF257	TI
		0.025	25*	70*	350	1K	50	2	Ultra Fast FET	LH0032	† National
		0.01*	50	10*	50	100K	74*		Fast Differential, FET settles to 0.01% in 1 μsec	141410	Teledyne P
	4	1	10	1*	0.5*	20K	80	0	Low Input Current	**AD502L**	**AD** **(575)**
				0.5*	—	15K	65	1	Low Input Current 709	AD801B	AD
		2	20	0.5*	—	15K	65	1	Low Input Current 709	AD801A	AD

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Single-Unit Package (Cont'd)											
5.0	4	2	40	0.5*	—	15K	65	1	Low Input Current 709	AD801S	† AD
	7	4	20	1*	0.5*	20K	80	0	Low Input Current	**AD502K**	**AD (575)**
	10	5	7*	1*	0.5*	20K	70	0	Low Input Current	8008M	† Intersil
			10*	—	0.1*	25K	74	0	Programmable Amplifier	**HA-2725**	**Harris (580)**
			20*	1*	0.5*	20K	80	0	Darlington 741	**AD502S**	**† AD (575)**
		6	—	.25*	0.16*	50K	70	0	Programmable	4250C	Intersil
										LM4250C	National
										SG4250C	Silicon G
										UC4250C	Solitron
	15	5	20	0.5*	0.1	45K	100*	0	Low Bias Current	3501A	Burr-Brown
										3501R	† Burr-Brown
	20	3	—	1*	2*	100K	80	0	High Voltage	MC1536	† Motorola
										SG1536	† Silicon G
				—	2.5*	100K	80	1	High Voltage	LM144	† National
	25	5	20	0.3*	0.13*	50K	70	0	Micropower	RC4132	Raytheon
		25	10*	12*	4	80K	74	0	High Inpedance	AM-460	Datel
										HA-2602	**† Harris (581)**
										HA-2605	**Harris (580)**
			15*	35*	20	80K	74	1	Wide Band, High Impedance	AM-462	Datel
										1018C	DDC
										HA-2622	**† Harris (581)**
										HA-2625	**Harris (580)**
			20*	12*	—	80K	74	0	Wideband	3506J	Burr-Brown
			30*	1	—	80K	74	1	Wideband	3508J	Burr-Brown
			—	10*	20	80K	100*	1	Wideband, High Gain	1321	Teledyne P
										132101	† Teledyne P
				12*	4	80K	74	0	High Impedance	1008C	DDC
	30	15*	20	1.5*	0.6	45K	100*	0	Low Bias, Low Noise	3500A	Burr-Brown
										3500R	† Burr-Brown
	35	7	20	0.1	0.12	25K	94	0	Micropower	140410	Teledyne P
		10	20	1.5	3	40K	70	0	High Performance, High Gain	RC1556A	Raytheon
	40	2.5	30*	1*	10	200K	80	0	Micropower FET High Current Out	1323	Teledyne P
		15	10	1*	10	200K	80	0	Wide Response, Low Power	1011C	DDC
										HA-2705	**Harris (580)**
5.0	40	20	0.5	0.2	2.5	1-1000	70	1	Full Instrumentation	**AD520K**	**AD (578)**
										AD520S	**† AD (578)**
	50	15	—	0.2	0.8*	100K	70	0	Programmable Low Power	MC1776	† Motorola
		20	20*	—	0.8	25K	80	0	General Purpose	1320	Teledyne P
			—	—	1.5*	25K	—	0	Low Input Bias, High Slew Rate	ULN-2171	Sprague
	100	20	10	2.5*	18*	25K	80	0	High Speed	OP-01C	PMI
										OP-01G	† PMI
			30	1*	0.5*	25K	70	1	Precision	µA777C	Fairchild
				0.5	0.5*	25K	70	1	Precision	SG777C	Silicon G
										µA777C	TI

† Military Temperature Range (−55°C to 125°C)

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Single-Unit Package (Cont'd)											
5.0	100	20	—	—	—	50K	70	0	High Performance 741C	SSS741C	AMD
		25	—	—	—	50K	70	0	High Performance 741	SSS741G	† PMI
	150	20	20	4*	2*	25K	70	0	High Performance, High Gain	RC4131	Raytheon
		40	6*	—	10	50K	70	0	High Slew Rate	NE535	Signetics
	180	25	6.6*	—	3*	22K	93	2	High Output Current	CA3033A	† RCA
			—	—	3*	22K	93	2	High Output Current	CA3047A	RCA
	200	20	5*		250	100K	80	1	High Slew Rate Inverting	1010C	DDC
										HA-2535	**Harris (580)**
		25	20*	12*	25	20K	80	0	High Slew Rate	**HA-2500**	**† Harris (581)**
										2500	† Intersil
		50	20*	8*	15*	50K	80	1	Four Addressable Inputs Single Amplifier	1454C	† DDC
										1454M	† DDC
										HA-2400	**† Harris (581)**
										HA-2404	**Harris (580)**
		60	3*	1*	0.25*	25K	70	2	Micropower, High Performance	LH0001AC	National
		—	10*	10*	130	25K	—	2	High Speed Inverting	8017M	† Intersil
	250	20	20	1*	0.5*	25K	96	1	General Purpose	LM301A	Raytheon
							96	0	General Purpose	LM307	Raytheon
			25	1*	0.4	50K	80	0	High Performance, Low Drift	1319	Teledyne P
		50	—	—	0.6*	25K	—	0	General Purpose	ULN-2151	Sprague
	300	150	10*	7*	3.5	25K	80	0	Low Noise	**HA-909**	**† Harris (581)**
	350	35	6.6*	—	2.7*	16K	84	2	High Output Current	CA3033	† RCA
			—	—	2.7*	16K	84	2	High Output Current	CA3047	RCA
	500	200	3*	0.5*	0.3*	25K	70	3	General Purpose	μA709M	† Fairchild
										ITT709-1	† ITT
										MC1709	† Motorola
										LM709	† National
										TAA522	† Siemens
										μA709	† Signetics
										709B	† Teledyne S
										TL1709	Telefunken
										μA709M	† TI
				0.8*	5*	50K	70	0	Wideband 741	SG1217	† Silicon G
				1*	0.5*	50K	70	0	General Purpose Compensated	741M	† AMD
										AD741	**† AD (575)**
										μA741M	† Fairchild
										741	† Intersil
										ITT741-1	† ITT
										MC1741	Motorola
										MC1741	† Motorola
										LM741	† National
										PM741	PMI
										CA741	† RCA
										RM741	† Raytheon
										μA741	† Signetics
										SG741	† Silicon G
										741B	† Teledyne S
										TL1741	Telefunken
										μA749M	† TI

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Single-Unit Package (Cont'd)											
5.0	500	200	3*	1*	0.5*	50K	70	0	Low Noise 741	741LN	† Intersil
										CA6741	† RCA
					10	50K	70	0	High Slew Rate 741	MC1741S	† Motorola
										SG741S	† Silicon G
					0.5*	50K	70	0	Compensated 101	LH101	† National
										LH101	† Raytheon
							70	1	General Purpose, Uncompensated	LM101	† AMD
										LM201	AMD
										µA101	† Fairchild
										LM101	† National
										CA101	† RCA
										LM101	† Raytheon
										LM101	† Signetics
										SG101	† Silicon G
							70	1	Uncompensated 741	748M	† AMD
										µA748M	† Fairchild
										MC1748	† Motorola
										LM748	† National
										LM748C	National
										CA748	† RCA
										RM748	† Raytheon
										µA748	† Signetics
										SG748	† Silicon G
										748B	† Teledyne S
										748C	Teledyne S
										µA748M	† TI
			4*	30*	0.7*	20K	70	2	Programmable	CA3094	† RCA
										CA3094A	† RCA
										CA3094B	† RCA
			—	0.5*	35	50K	70	1	High Slew Rate	RM4531	† Raytheon
				1*	0.7	50K	70	0	High Speed 741	741MHS	† Intersil
					30*	50K	70	1	High Slew Rate	NE531	Signetics
	750	250	6*	65*	15	15K	74	3	High Speed High Gain	µA715M	† Fairchild
										715	† AMD
	10000	2000	10*		1.7*	1.4K	70	3	General Purpose	TL702M	† TI
										MC1530	† Motorola
	12000	5000	1.2*	15*	3*	0.7K	70	1	6 Volt, Wideband	CA3008	† RCA
										CA3010	† RCA
										CA3029	RCA
										CA3037	† RCA
	2000	400	—	38*	25*	0.6K	76	1	Large Signal Wideband	CA3100	† RCA
	7500	2000	5*	7*	1.5*	2K	70	2	Wideband	MC1712C	Motorola
			20	30*	3.5*	2K	70	3	Wideband	µA702C	Fairchild
										SL702C	Plessey
										RC702	Raytheon
	24000	5000	3.5*	50*	7*	2K	80	1	12 Volt, Wideband	CA3015	† RCA
										CA3016	† RCA
										CA3030	RCA
										CA3038	† RCA
6.0	0.025	0.002	15	1*	1	75K	70	0	High Performance FET	LH0022C	National
	4	0.5	10*	3*	9*	25K	70	0	JFET	TL081AC	TI
	25	10	6*	—	0.2*	75K	70	0	Programmable	SG3250	Silicon G

† Military Temperature Range (−55°C to 125°C)

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Single-Unit Package (Cont'd)											
6.0	25	12	40	1*	0.5*	20K	80	0	Low Input Current	**AD502J**	**AD (575)**
		20	15*	—	0.5*	20K	70	0	Low Input Current	8008C	Intersil
		25	15*	35*	20	80K	74	1	Wideband, General Purpose	**AD507J**	**AD (574)**
	30	30	15*	4*	5*	100K	74	0	High Voltage	AM-464	Datel
										HA-2645	**Harris (580)**
										1332	Teledyne P
	35	10	5*	0.27*	0.16*	50K	70	0	Low Power Adjustable Current	1003	DDC
										8021C	Intersil
	50	25	—	0.2	0.8*	50K	70	0	Programmable Low Power	MC1776C	Motorola
										MC3476	Motorola
	100	25	—	—	—	20K	70	0	High Performance 741C	SSS741C	PMI
		30	—	—	0.3	40K*	—	1	Supply to -10v	TCA520	Signetics
	250	50	—	1*	0.5	25K	80	0	to 500 ma, single supply	μA759C	Fairchild
	500	200	3*	1*	10	20K	70	0	High Slew Rate 741	MC1741SC	Motorola
										SG741SC	Silicon G
			5*	0.8*	5*	20K	70	0	Wideband 741C	SG3217	Silicon G
				1*	1	100K	70	1	0.2 amp Power	LH0041C	National
			10*	1*	0.25	100K	90	2	High Gain, Instrumentation 50 ma Output	LH0020C	National
					0.5*	25K	70	0	Low Noise 741	741CLN	Intersil
			15*	0.2*	0.2*	20K	70	0	High Power	μA791C	Fairchild
			30	1*	1*	100K	70	0	1.0 amp Power	LH0021C	National
			—	1*	0.5*	20-50K	70	1	General Purpose	748C	AMD
										μA748C	Fairchild
										MC1748C	Motorola
										SFC748C	NPC
										SL748	Plessey
										CA748C	RCA
										RC748	Raytheon
										μA748C	Signetics
										SG748C	Silicon G
										μA748C	TI
					0.5	20-50K	70	0	General Purpose Compensated	**AD741C**	**AD (575)**
										μA741C	Fairchild
										HA17741	Hitachi
										741C	Intersil
										ITT741-5	ITT
										MC1741C	Motorola
										LM741C	National
										SFC741C	NPC
										PM741C	PMI
										CA741CC	RCA
										RC741	Raytheon
										μA741C	Signetics
										TBA221D	Signetics
										SG741C	Silicon G
										741C	Teledyne S
										TL1741C	Telefunken
										TL3741C	Telefunken
										TL4741C	Telefunken
										μA741C	TI

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Single-Unit Package (Cont'd)											
6.0	500	200	—	1*	0.7	25K	70	0	High Speed 741	741CHS	Intersil
				—	1	20K	70	1	1 amp	883-21C	Beckman
		300	10*	7*	5*	20K	74	0	Low Noise	**HA-911**	**Harris (580)**
				12*	50	25K	70	0	High Speed, Fast Settling	**AD518J**	**AD (574)**
	600	60*	30	0.7*	0.6	32K	90*	1	General Purpose	3057	Burr-Brown
				0.9*	0.9	45K	80*	1	General Purpose	3053	Burr-Brown
	1000	300	6*	—	18*	5K	60	0	20ma Output	TCA325	Siemens
						12K	65	1	20ma Output	TAA761	Siemens
										TAA765	Siemens
						18K	70	1	20ma Output	TAA762	† Siemens
										TAA862	† Siemens
	1200	500	5*	4*	4*	10K	70	2	Gated	ZN424	Ferranti
	1500	200	—	0.5*	35*	20K	70	1	High Slew Rate	RC4531	Raytheon
				1*	20*	20K	70	1	High Slew Rate High Performance	SE531	† Signetics
7.0	200	10*	10*	10*	130*	25K	—	2	High	8017C	Intersil
7.5	7	1	30	1*	0.3*	25K	80	0	Micropower, Supply Current 800µa	LM312	AMD
										LM312	National
										LM312	Raytheon
				0.3*	0.1	25K	80	0	Compensated 308	SG3118	Silicon G
				1*	0.3*	25K	80	1	Precision Bipolar	LM308	AMD
										AD308	**AD (575)**
										µA308C	Fairchild
										LM308	Intersil
										MLM308	Motorola
										LM308	National
										SFC2308	NPC
										PM308	PMI
										CA308	RCA
										LM308	Raytheon
										LM308	Signetics
										SG308	Silicon G
			—	0.3*	0.3*	25K	80	1	Low Noise 308	308LN	Intersil
	15	2	30		0.1	25K	80	1	Precision	1660	AMD
				0.3*	0.1	25K	80	1	Improved 201, 301A	SG1660	Silicon G
							80	0	Improved 307, 741	SG1760	Silicon G
	250	50	30	1*	0.5*	25K	70	0	General Purpose, Uncompensated	LM307	AMD
										µA307C	Fairchild
										307	Intersil
										MLM307	Motorola
										LM307	National
										SFC2307	NPC
										CA307	RCA
										LM307	Signetics
										SG307	Silicon G
										LM307	TI
					0.5	25K	70	1	General Purpose, Compensated	LM301A	AMD
										AD301A	**AD (575)**
										µA301A	Fairchild
										301A	Intersil
										MLM301A	Motorola
										(Cont'd)	

† Military Temperature Range (−55°C to 125°C)

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source	
Single-Unit Package (Cont'd)												
7.5	250	50	30	1*	0.5	25K	70	1		(Continued)		
										LM301A	National	
										SFC2301A	NPC	
										CA301A	RCA	
										LM301A	Signetics	
										SG301A	Silicon G	
										LM301A	Teledyne S	
										LM301A	TI	
			—	0.8*	0.5*	25K	70	1	Low Noise 301A	301ALN	Intersil	10
	600	60	5*	1*	34*	40K	80	3	Fast General Purpose	133901	Teledyne P	
	1000	100	12*	1*	34*	15K	80	3	Fast General Purpose	1339	Teledyne P	
		150	3*	2*	4.2*	15K	80	2	General Purpose	MC1439	Motorola	
	1500	250	6	65*	10	10K	74	3	High Speed	715C	AMD	
										µA715C	Fairchild	
		500	6*	1*	0.5*	20K	65	0	Compensated 201	LH201	National	
										LH201	Raytheon	
							65	1	General Purpose	LM301	AMD	
										µA201M	Fairchild	
										LM201	National	20
										CA201	RCA	
										LM201	Raytheon	
										LM201	Signetics	
										SG201	Silicon G	
			6-10*	1*	0.3*	15K	65	3	General Purpose	µA709C	Fairchild	
										ITT709-5	ITT	
										LM709C	National	
										RC709	Raytheon	
										TAA521	Siemens	
										µA709C	Signetics	30
										709C	Teledyne S	
										TL1709C	Telefunken	
										TL3709C	Telefunken	
										µA709C	TI	
	2000	100	—	—	4.2*	50K	—	2	High Slew Rate	ULN-2139	Sprague	
8.0	40	10	—	1*	2.5*	70K	70	1	High Voltage	LM344	National	
	100	30	—	6*	15	30K	70	0	Wideband 741	TCA680	Signetics	
	200	25	20*	10*	50	10K	80	0	High Slew Rate	1009M	† DDC	
										HA-2510	**† Harris**	**(581)**
				120*	10K	80	1	1	100V/µs, Gain 3	**HA-2520**	**† Harris**	**(581)** 40
										2520	† Intersil	
			30	20*	100	10K	80	1	High Speed, Fast Settling	**AD509K**	**AD**	**(574)**
										AD509S	**† AD**	**(574)**
	250	50	20*	12*	20	15K	74	0	High Slew Rate	AM-450	Datel	
										HA-2502	**† Harris**	**(581)**
										HA-2505	**Harris**	**(580)**
										2502	† Intersil	
										2505	Intersil	
				6*	20	16K	74	0	Fast Slewing	3505J	Burr-Brown	
	40000	15000	25*	70*	250	3K	60*	3	High Slew Rate	LH0024C	National	50
9.0	250	50	30*	8*	15*	50K	74	1	Four Addressable Inputs Single Amplifier	**HA-2405**	**Harris**	**(580)**
	0.010	0.0005*	10	1*	3	50K	70	0	FET Input	8007C-4	Intersil	

† Military Temperature Range (−55°C to 125°C)

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LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Single-Unit Package (Cont'd)											
9.0	0.010	0.0005*	15	1*	3	50K	70	0	FET Input	8007C-5	Intersil
										8007M-5	† Intersil
	0.050	0.020*	30	3*	15*	20K	86*	0	High Voltage FET	3580J	† Burr-Brown
		0.025	100	—	—	37K	60	0	FET Input 741	2740C	Teledyne S
	0.10	0.02	10	3*	7*	25K	70	0	JFET	TL081	TI
	0.15	0.01	55	30	8	20K	94		FET	Q25AH	† Teledyne P
		0.05	—	1*	0.3*	20K	80	0	High Performance, Low Input Current		
										LM216	AMD
										LM316	AMD
										LM216	National
										LM316	National
										LM216	Raytheon
										LM316	Raytheon
	0.20	0.05	5*	2.5	5*	25K	80	0	Bipolar - JFET	LF355	AMD
										μAF355	Fairchild
										LF355	Intersil
										LF355	National
										PM355	PMI
										LF355	Raytheon
										LF355	TI
				5	15	25K	80	0	Wideband - JFET	LF356	AMD
										μAF356	Fairchild
										LF356	Intersil
										LF356	National
										PM356	PMI
										LF356	Raytheon
										LF356	TI
					15*	25K	80	1	Wideband Uncompensated	LF357	AMD
										μAF357	Fairchild
										LF357	Intersil
										LF357	National
										PM357	PMI
										LF357	Raytheon
										LF357	TI
	30	10	20	4*	2*	40K	70	0	High Performance, High Gain	RC1556	Raytheon
			—	1*	2.5*	70K	70	0	High Performance	MC1456	Motorola
										SG1456	Silicon G
	40	10	—	1*	2*	70K	70	0	High Voltage	MC1436	Motorola
										MC1456	Signetics
										SG1436	Silicon G
	50	20	20*	—	—	2K	55	3	Matched Input Transistors	LH0005	† National
	80	40	1000	0.2	2.5	1-1000	-65	1	Full Instrumentation	**AD520J**	**AD** (578)
	100	25	25*	—	—	2K	50	3	Matched Input Transistors	LH0005C	† National
	250	50	20*	20*	80	7.5K	74	1	High Speed, Fast Settling	**AD509J**	**AD** (574)
			25*	12*	40	7.5K	74	0	High Slew Rate	**HA-2512**	**† Harris** (581)
				20*	80	7.5K	74	1	80V/μs Gain 3	**HA-2522**	**† Harris** (581)
										2522	† Intersil
			30*	12*	40	7.5K	74	0	High Slew Rate	**HA-2515**	**Harris** (580)
					80	7.5K	74	1	80V/μs Gain 3	AM-452	Datel
										1009C	DDC
										HA-2525	**Harris** (580)
										2525	Intersil

† Military Temperature Range (−55°C to 125°C)

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Single-Unit Package (Cont'd)											
9.0	250	50	30*	20*	80	7.5K	89*	1	High Slew Rate	1322	Teledyne P
										132201	† Teledyne P
				—	80	7K	74	1	Fast Slewing	3507J	Burr-Brown
	500	200	5*	1*	25	25K	60	1	0.5A, wideband	LH0061C	National
										LH0061C	TI
			—	15*	50	25K	70	0	Precision, high speed	LM318	AMD
										LM318	Fairchild
										LM318	National
										SFC2318	NPC
										LM318	TI
	600	200	—	15*	50	25K	70	2	Precision, High Speed	LM318	Raytheon
	750	50	5	—	5	20K	80	—	Wideband	1317	Teledyne P
	1000	300	6*	—	18*	0.56K	60	1	to 20 ma Output	TAA861	Siemens
										TAA865	Siemens
										TAA861	Telefunken
										TAA865	Telefunken
	15000	5000	5*	—	1.7*	1K	65	3		TL702C	TI
	2000	100	2*	10*	5*	1K	75	2	Differential Output	MC1520	† Motorola
12.0	0.020	0.02	20*	5*	10*	80K	74	1	Wideband, FET Input	HA-2060A	† Harris
			40*	5*	10*	80K	70	1	Wideband, FET Input	HA-2065A	Harris
	90	25	—	1*	2*	50K	50	0	High Voltage	MC1436C	Motorola
										SG1436C	Silicon G
		30	—	1*	2.5	25K	110*	0	High Performance	MC1456C	Motorola
										SG1456C	Silicon G
14.0	0.020	0.02	20*	8*	40*	7.5K	74	1	120V/µs Gain 3	HA-2050A	† Harris
										143401	† Teledyne P
			40*	8*	40*	7.5K	70	1	120V/µs Gain 3	HA-2055A	Harris
										1434	Teledyne P
	20	—	35*	20*	60	40K*	90	0	High Slew Rate	14301	† Teledyne P
			75*	20*	60	40K*	90	0	High Slew Rate	1434	Teledyne P
15.0	0.010	0.005	25	1	3	100K	80	0	General Purpose, Low Drift	142102	Teledyne P
	0.015	0.01	25	1	3	100K	72	0	Low Noise	1421-25	Teledyne P
			50	1	3	100K	72	0	General Purpose, Low Drift	142101	Teledyne P
		0.01*	50	5	8	100K	72	—	Wideband, FET	142201	Teledyne P
	0.020	0.01	10*	0.14*	1*	1-1000	75*	2	Instrumentation	LF152	† National
	0.050	0.025	50	1	3	50K	72	0	General Purpose	1421	Teledyne P
				—	—	50K	72	0	Low Noise	1421-24	Teledyne P
		0.025*	50	5	8	50K	72	—	Wideband, FET	1422	Teledyne P
		0.030	10*	4*	10*	320K*	70	1	CMOS, Single Supply; Strobe	CA3130	† RCA
			—	4.5*	9*	20K	70	0	MOS FET, Single Supply	CA3140	RCA
	0.065	0.005	35	15*	50	25K	70	0	Precision, High Speed, FET	LH0062C	National
	0.20	0.05	10*	1*	0.5*	25K	90	0	JFET-741	LF13741	National
			25*	50*	350	1K	50	2	Ultra Fast FET	LH0032C	National
		0.10	5*	1*	6*	50K	80	0	FET Input	LH740A	† National
			15*	1*	6*	50K	80	0	FET Input	740	† Intersil
	4.0	0.5	10*	3*	9*	25K	70	0	JFET	TL081C	TI

† Military Temperature Range (−55°C to 125°C)

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LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Single-Unit Package (Cont'd)											
	4000	200	2*	10*	5*	0.75K	60	2	Differential Output	MC1420	Motorola
20.0	0.00001	—	100	—	0.5*	20K	60	0	Ultra Low Bias FET	ICH8500A	Intersil
	0.0001	—	—	—	0.5*	20K	60	0	Ultra Low Bias FET	ICH8500	Intersil
	0.005	—	30	0.5*	3	40K	80	0	Electrometer, FET	**AD523K**	**AD (574)**
			—	—	—	25K	—	0	Inverting Separate FET Input	L137CA	Siliconix
	0.010	0.002*	25	1*	2.5	31K	86*	0	High Performance, Low Bias FET	3503B	Burr-Brown
										3503S	† Burr-Brown
		—	25	0.75*	0.5*	50K	70	0	Low Noise FET	**AD514L**	**AD (574)**
	0.020	0.0005*	75	1*	6*	50K	70	0	High Performance FET	8007M	† Intersil
		—	25	1*	3	50K	80	1-3	50V/µs Feed Forward	AD513K	AD
				0.75*	0.5	50K*	70	0	Low Noise FET	**AD514K**	**AD (574)**
			50	0.75*	0.5*	50K*	70	0	Low Noise FET	**AD514S**	**† AD (574)**
				1*	3	50K	80	1-3	50V/µs Feed Forward	AD513S	† AD
	0.025	0.002*	50	1*	0.5*	25K	80*	0	Low Noise	3542J	Burr-Brown
										3542S	† Burr-Brown
		0.010	20	1*	1.5	50K	70	0	Low Cost FET	LH0042	† National
		—	25	1*	6*	50K	70	0	Low Cost FET Input	**AD540K**	**AD (574)**
			50	1*	6*	50K	70	0	Low Cost FET Input	**AD540S**	**† AD (574)**
					0.5*	25K	80	0	FET	AD3542J	AD
			60	0.5*	3	40K	80	0	Electrometer, FET	**AD523L**	**AD (574)**
	0.030	0.005*	20*	1*	6*	50K	70	0	FET	SU536	Signetics
	0.050	0.005	25	1*	1	25K	70	0	Low Cost FET	LH0042C	National
		0.025	150	—	—	20K	60	0	FET Input 741	2740D	Teledyne S
		—	25	1*	6*	25K	70	0	Low Cost FET	AD0042C	AD
	0.10	—	25	1*	3	50K	80	0	Low Cost FET Input	**AD503K**	**AD (574)**
										AD503S	**† AD (574)**
	0.20	0.15	20*	3*	6*	50K	64	0	High Slew Rate FET	µA740M	† Fairchild
										740	Intersil
			25	100	600	—	—	0	Wideband Inverting	HVA23	DDC
			—	100	1000	—	—	0	Wideband Inverting	HFB7	DDC
	0.50	0.15	5*	1*	6*	50K	80	0	FET Input	LH740AC	National
			15*	1*	6*	50K	80	0	FET Input	740C	Intersil
	50	25	200	—	—	3K	60	0	Darlington Input	TCA315	Siemens
							60	1	Darlington Input	TCA335	Siemens
25.0	0.020	0.02	50*	5*	10*	80K	74	1	120V/µs Gain 3	1015M	† DDC
										HA-2060	† Harris
										143301	† Teledyne P
				8*	40*	7.5K	74	1	High Slew Rate, FET	1014M	† DDC
										HA-2050	† Harris
30.0	0.001	0.0002*	50	1*	2.5	20K	86	0	Low Bias FET	1001M	† DDC
										8007AM	† Intersil
										8007AC	Intersil
		—	50*	1*	6*	20K	86	0	FET	1439	Teledyne P
	0.040	0.020	10*	0.14*	1*	1-1000	65	0	Instrumentation	LF252	National
										LF352	National

† Military Temperature Range (−55°C to 125°C)

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source	
Single-Unit Package (Cont'd)												
30.0	30*	2	0.06*	1*	6*	1000K	80*	0	High Slew Rate FET	µA740C	Signetics	
50.0	0.001	0.0005*	90	0.5*	3	20K	70	0	Electrometer, FET	**AD523J**	**AD**	**(574)**
	0.015	—	75	1*	3	20K	70	0	Low Cost FET Input	**AD503J**	**AD**	**(574)**
	0.020	—	75	1*	6*	50K	70	0	Low Performance Limit, See 1101M111 1001M664	1001M664	† DDC	
	0.025	0.005*	75	1*	2.5	20K	86*	0	High Performance, Low Bias FET	3503A	Burr-Brown	
										3503R	† Burr-Brown	
	0.030	—	75	1*	3	20K	70	1-3	50V/µs Feed Forward	AD513J	AD	10
	0.050	0.0005*	75	1*	6*	20K	70	0	High Performance, FET	3540J	Burr-Brown	
										1001	DDC	
										8007C	Intersil	
							70		Low Cost FET	1424	Teledyne P	
		—	75	0.75*	0.5*	20K	70	0	Low Noise FET	**AD514J**	**AD**	**(574)**
				1*	6*	20K	70	0	Low Cost FET	**AD540J**	**AD**	**(574)**
							70	0	Low Performance Limit, See 1001C111 1001C665	1001C665	DDC	
60.0	0.020	0.02	60*	5*	10*	80K	70	1	Wideband, FET Input	AM-406	Datel	
										1015C	DDC	20
										HA-2065	Harris	
										1433	Teledyne P	
				8*	40*	7.5K	70	1	120V/µs Gain 3	AM-405	Datel	
										1014C	DDC	
										HA-2055	Harris	
90.0	0.10	0.005*	30*	1*	6*	50K	64	0	FET, High Input, High Impedance	NE536	Signetics	
110.0	2	0.3	20*	1*	6*	20K	55	0	High Slew Rate FET	µA740C	Fairchild	
			—	1*	6*	20K	55	0	High Slew Rate FET	740C	Intersil	
—	150	—	25	50	400	—	—	0	Fast Settling, Inverting	HFS23	DDC	30
Dual-Unit Package												
0.5	2	0.2	15	1*	0.3*	80K	96	1	Dual 108A	LH2108A	† National	
										LH2208A	National	
										LH2108A	† Signetics	
										LH2208A	Signetics	
	3	2.8	2	1.2*	0.25*	200K	114	0	Dual Matched Instrumentation	OP-10	† PMI	
										OP-10A	† PMI	
	4	3.8	2	1.2*	0.25*	200K	110	0	Dual Matched Instrumentation	OP-10E	PMI	40
	7	1	30	1*	0.3*	80K	96	1	Dual 308A	LH2308A	National	
										LH2308A	Signetics	
0.75	50	2	8	0.8	0.4	100K	90	0	Dual Matched	OP-04A	† PMI	
										OP-04E	PMI	
										OP-14A	† PMI	
										OP-14E	PMI	
1.3	7	6	4.5	1.2*	0.25*	120K	100	0	Dual Matched Instrumentation	OP-10C	PMI	
2.0	0.05	0.01	5	2,5*	3	50K	85	0	JFET	LF2115A	† TI	
					5	50K	85	0	JFET	LF2355A	TI	50
				4	10	50K	85	0	JFET Wideband	LF2156A	† TI	
										LF2356A	TI	

† Military Temperature Range (−55°C to 125°C)

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LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Dual-Unit Package (Cont'd)											
2.0	0.05	0.01		—	—	50K	85	—	for gains 5	LF2157A LF2357A	† TI TI
	2	0.2	15	1*	0.3*	50K	85	1	Dual 108	LH2108 LH2208 LH2108 LH2208	† National National † Signetics Signetics
	50	5	10	0.8	0.4	50K	90	0	Dual Matched	OP-04 OP-04C OP-14 OP-14C	PMI PMI † PMI PMI
			—	—	—	100K	80	0	Dual High Performance 741	SSS747 SSS747	† AMD † PMI
		10	15	1*	—	50K	90	0	Low Power	LM158A	National
		25	5	1.5*	0.8	100K*	100*		Matched Amplifier Pairs	3500MP	Burr-Brown
	75	10	15	1*	0.5*	50K	80	1	Dual LM101A High Performance	LH2101A LH2201A LM2101 LM2201 LH2101A LH2201A LH2101A LH2201A	† AMD AMD † Motorola Motorola † National National † Signetics Signetics
3.0	5	3	10*	25*	0.1*	40K	80	0	Programmable	**HA-2730**	**† Harris (581)**
	15	5	—	.25*	0.16*	100K	70	0	Programmable Dual LM4250	LH24250	† National
	20	7.5	5*	0.27*	0.16*	50K	70	0	Low Power Adjustable Current	8022M	† Intersil
	50	5	—	—	—	50K	80	0	Higher Performance	SSS747B	PMI
	80	15	15	1*	—	50K	70	0	Low Power	LM258A	National
		30	15	0.44	0.3	50K	80	0	Dual 741	µA747AM µA747EC LM747A LM747E	† Fairchild Fairchild † National National
	100	30	8*	8*	2	25K	80	0	High Slew Rate	**HA-2650**	**† Harris (581)**
			20	1*	—	25K	65	0	Low Power, Single Supply	LM358A	National
	750	400	3*	—	2*	20K	70	3	Audio Preamp	µA749C µA749M	Fairchild † Fairchild
5.0	0.10	0.02	5*	2.5*	5*	50K	85	0	JFET	LF2155 LF2255	† TI TI
				4.5	7.5	50K	85	0	JFET Wideband	LF2156 LF2256	† TI TI
				—	—	50K	85	—	for gains µ 5	LF2157 LF2257	† TI TI
	7.5	3	3*	1*	15*	200K	70	0	Multi-Purpose Programmable	µA776M	† Fairchild
	10	5	10*	—	0.1*	25K	74	0	Programmable	**HA-2735**	**Harris (580)**
		25	10*	1*	0.6*	50K	70	0	Single Supply, I/O operates to ground	µA798M MC3558	† Fairchild † Motorola
	100	25	—	—	—	50K	70	0	Dual High Performance 741C	SSS747C SSS747C (Cont'd)	AMD PMI

† Military Temperature Range (−55°C to 125°C)

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Dual-Unit Package (Cont'd)											
5.0	100	25	—	—	—	50K	70	0		(Continued)	
										SSS747G	† PMI
										SSS1458	PMI
										SSS1558	† PMI
		40	—	0.8*	0.5*	4K	60	0	Low Power	TL022M	† TI
	150	30	7*	—	—	50K	70	0	Half LM124	MLM158	† Motorola
										LM158	† National
										LM258	National
										LM158	† TI
	200	60	8*	8*	2	20K	74	0	High Slew Rate	**HA-2655**	**Harris (580)**
		80	—	0.8*	0.5*	1K	60	0	Low Power	TL022C	TI
	250	30	—	1*	—	100K*	85*	0	Half LM124	SE532	† Signetics
	500	200	2-15*	1*	0.5*	50K	70	0	Dual 741	747M	† AMD
										1558	† AMD
										XR1558	† Exar
										μA747M	† Fairchild
										μA1558M	† Fairchild
										MC1747	† Motorola
										MC1558	† Motorola
										MC4558	Motorola
										LM747	† National
										LM1558	† National
										PM747	† PMI
										PM1558	† PMI
										CA747	† RCA
										CA1558	† RCA
										RM747	† Raytheon
										RM1558	† Raytheon
										MC1558	† Signetics
										μA747	† Signetics
										SG747	† Silicon G
										SG1558	† Silicon G
										747B	† Teledyne S
										1558	† Teledyne S
										μA747M	† TI
										MC1558	† TI
			—	2	1.5*	50K	70	0	Wideband 741	RM4558	† Raytheon
										RM4558	† TI
				—	10	25K	70	0	High Slew Rate 1558	MC1558S	† Motorola
6.0	10	6	3*	1*	15*	50K	70	0	Multi-Purpose Programmable	μA776C	Fairchild
	30	10	5*	0.27*	0.16*	50K	70	0	Low Power Adjustable Current	8022C	Intersil
			—	.25*	0.16*	75K	70	0	Programmable Dual LM4250	LH24250C	National
	250	50	7*	—	—	25K	65	0	Half LM244/324	MLM258	Motorola
										MLM358	Motorola
							70	0	JFET	NE532	Signetics
		75	10*	1*	0.6*	20K	70	0	Single Supply, I/O operates to ground	μA798C	Fairchild
										MC3458	Motorola
	500	200	—	1*	0.5*	20-50K	70	0	Dual 741C	1458	AMD
										747C	AMD
										XR1458	Exar
										μA747C	Fairchild
										μA1458C	Fairchild
										(Cont'd)	

† Military Temperature Range (−55°C to 125°C)

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LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift μV/°C	Band-width MHz	Slew Rate v/μs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Dual-Unit Package (Cont'd)											
6.0	500	200	—	1*	0.5*	20-50K	70	0		(Continued)	
										MC1747C	Motorola
										LM747C	National
										LM1458	National
										PM747C	PMI
										PM1458	PMI
										CA747C	RCA
										CA1458	RCA
										RC747	Raytheon
										RC1458	Raytheon
										μA747C	Signetics
										MC1458	Signetics
										SG747C	Silicon G
										SG1458	Silicon G
										747C	Teledyne S
										1458	Teledyne S
										μA747C	TI
										MC1458	TI
				3*	1*	20K	70	0	Wideband 741	XR4558	Exar
										μA4558	Fairchild
										MC4558C	Motorola
										RC4558	Raytheon
										RC4558	TI
							70	0	Low Noise	XR4739	Exar
										RC4739	Raytheon
				—	10	15K	70	0	High Slew Rate 1458	MC1458S	Motorola
	1000	500	—	—	—	12K*	70	2	Low Noise	TCA490	Signetics
	2000	1000	—	—	1*	6.5K	70	2	Single Supply	μA739	Fairchild
										TBA231	SGS
7.0	250	50	7*	1*	—	25K	65	0	Half LM224	LM258	National
										LM358	National
										NE532	Signetics
										LM258	TI
										LM358	TI
						100K	50	0		LM2904	National
7.5	7	1	30	1*	0.3*	25K	80	1	Dual 308	LH2308	National
	250	50	30	1*	0.5*	25K	70	1	Dual High Performance	LH2301A	AMD
										LH2301A	National
	1500	500	1.5*	1*	0.3*	15K	65	3	Matched Dual 709	RC1437	Raytheon
					0.25*	15K	65	3	Matched Dual MC1709C	MC1437	Motorola
10.0	0.20	0.05	5*	2.5*	5*	25K	80	0	JFET	LF2355	TI
				4.5	12*	25K	80	0	JFET, Wideband	LF2356	TI
				—	—	25K	80	—	for gains μ 5	LF2357	TI
	700	300	15*	1.1*	0.8*	20K	60	0	General Purpose	μA1458CC	Fairchild
										MC1458C	Motorola
										1458C	Teledyne S
	1500	600	—	—	—	10K	70	0	Audio Preamp	μA749D	Fairchild
20.0	0.02	0.0005*	75	1*	6*	50K	70	0	FET Input Dual	1002M	† DDC
										8043M	† Intersil
50.0	0.05	0.0005*	75	1*	6*	20K	70	0	FET Input Dual	1002C	DDC
										8043C	Intersil

† Military Temperature Range (−55°C to 125°C)

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Triple Unit Package (Cont'd)											
Triple Unit Package											
2.0	500	250	5*	10*	—	4K	90*	0	Two amplifiers of Triple unit, includes 5v regulAtor	ZN417	Ferranti
3.0	30	7.5	5*	0.27*	0.16*	50K	70	0	Low Power Programmable	8023M	† Intersil
5.0	70	14	—	0.02*	0.1*	—	70	0	Micropower, Transconductance Amplifier	CA3060	† RCA
	200	50	3.3*	0.6*	0.4*	3K	80	0	Programmable	**L144A**	**† Siliconix (604)**
										L144B	**Siliconix (604)**
	550	100	—	0.045*	1*	—	70	0	Micropower, Transconductance Amplifier	CA3060	† RCA
	5000	1000	—	0.11*	8*	—	70	0	Micropower, Transconductance Amplifier	CA3060	† RCA
6.0	30	10	5*	0.27*	0.16*	50K	70	0	Low Power Programmable	8023C	Intersil
10.0	250	70	3.3*	0.6*	0.4*	1K	70	0	Programmable	**L144C**	**Siliconix (604)**
	2000	200*	—	5	0.46	4K*	90*	2	Supply ±6	TCA220	Signetics
20.0	50	25	—	0.5*	—	4K	90*	0	Low input current amplifier of triple includes 5v regulAtor	ZN417	Ferranti
Quad Unit Package											
2.0	50	10	20	1*	—	50K	70	0	Low Power	LM124A	† National
2.5	160	50	2*	10*	4*	100K	86	0	Wideband	**HA-4602**	**† Harris (582)**
3.0	80	15	20	1*	—	50K	70	0	Low Power	LM224A	National
	100	30	30	1*	—	25K	65	0	Low Power	LM324A	National
	200	30	5*	2.8	1.3	25K	80	0	Noise 2µV max	**RM4156**	**† Raytheon (592)**
				3.5*	1.6*	50K	80	0	Quad 741	**HA-4741-2**	**Harris (580)**
										HA4741-2	**† Raytheon (598)**
3.5	240	100	2*	10*	4*	75K	80	0	Wideband	**HA-4605**	**Harris (580,582)**
4.0	400	50	5*	1*	1.2*	50K	70	0	LM124 with improved output	RM3503A*	**† Raytheon (586)**
5.0	100	25	—	1*	0.5*	50K	70	0	Quad 741 with standard npn input stage	LM148	† AMD
										LM148	† Intersil
										LM248	Intersil
										MC4741	† Motorola
										LM148	† National
										LM148	† Raytheon
				4*	2.0*	50K	70	0	Wideband quad 741 for gains 5	LM149	† AMD
										LM249	AMD
										L149	† National
										LM249	National
		40	—	0.8*	0.5*	4K	60	0	Low Power	TL044M	† TI
	150	30	7*	1*	—	50K	70	0	Single Supply; I/O Operates to ground	LM124	† AMD
										LM224	AMD
										LM124	† Fairchild
										LM124	† Intersil
										MLM124	† Motorola
										(Cont'd)	

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift μv/°C	Band-width MHz	Slew Rate v/μs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Quad Unit Package (Cont'd)											
5.0	150	30	7*	1*	—	50K	70	0		(Continued)	
										MLM224	Motorola
										LM124	† National
										LM224	National
										LM124	† Raytheon
										LM224	Raytheon
										CA124	† RCA
										LM124	† Signetics
										SG124	† Silicon G
										LM124	† TI
										LM224	TI
	250	80	—	0.8	0.5*	1K	60	0	Low Power	TL044C	TI
	300	30	—	1*	0.6	50K	70	0	Quad 741	835B	† Teledyne S
				1.5*	0.8	50K	70	0	Quad 741	836B	† Teledyne S
		50	5*	2.8	1.3	15K	80	0	Noise 2μV max	**RC4156**	**Raytheon (592)**
										RV4156	**Raytheon**
				3.5*	1.6*	25K	80	0	Quad 741	**HA-4741-5**	**Harris (580)**
										HA4741-5	**Raytheon (598)**
	500	50	10*	1*	0.6*	50K	70	0	Single Supply; I/O Operates to ground	XR3503	† Exar
										μA3503M	† Fairchild
										MC3503	† Motorola
										RM3503	**† Raytheon (586)**
			—	2	1.5*	5K	70	0	Programmable Quad 741	XR4202	Exar
					1.6*	20K	70	0	Quad 741	XR4212M	† Exar
		200	—	2	1.5*	50K	70	0	Quad 741, High Gain	XR4136M	† Exar
										μA4136M	† Fairchild
										PM1436	† PMI
										RM4136	**† Raytheon (588)**
										RM4136	† TI
6.0	0.5	0.05	5	10	20	50K	70	0	FET, wideband	MC3471	Motorola
										MC3571	† Motorola
	200	50	—	1*	0.6*	25K	70	0	Quad 741 with standard npn input stage	LM248	AMD
										LM348	AMD
										μA348	Fairchild
										LM248	Intersil
										LM348	Intersil
										MC4741C	Motorola
										LM348	National
				5*	3.5*	25K	70	0	Wideband quad for gains≥5	LM349	AMD
										μA349	Fairchild
	500	50	—	1*	1.2*	25K	70	0	LM324 with improved output	**RC3403A**	**† Raytheon (586)**
										RV3403A	**Raytheon (586)**
				2	1.6	5K	70	0	Quad 741	XR4212C	Exar
		100	—	1*	0.6*	25K	70	0	Quad 741	835C	Teledyne S
		200	—	3*	1*	20K	70	0	Quad 741	XR4136C	Exar
										μA4136C	Fairchild
										PM4136C	PMI
										RC4136	**Raytheon (588)**
										RC4136	† TI
				1*	0.5*	20K	70	0	Quad 741	MC4741C	Motorola

† Military Temperature Range (−55°C to 125°C)

"Comp" indicates number of compensation components required.

LINEAR—Operational Amplifiers-Characteristics (Cont'd)

Offset Voltage mv (25°C)	Bias Current na. (25°C)	Offset Current na. (25°C)	Voltage Drift µv/°C	Band-width MHz	Slew Rate v/µs	Voltage Gain v/v	CMRR db	Comp.	Comments	Device	Source
Quad Unit Package (Cont'd)											
7.0	250	50	7*	1*	—	25K	65	0	Single Supply; I/O Operates to ground	LM324	AMD
										µA224	Fairchild
										µA324	Fairchild
										XR324	Exar
										LM224	Intersil
										LM324	Intersil
										MLM324	Motorola
										LM324	National
										CA224	RCA
										CA324	RCA
										LM324	Raytheon
										LM224	Signetics
										LM324	Signetics
										SA534	Signetics
										SG224	Silicon G
										SG324	Silicon G
										LM224	TI
										LM324	TI
						100K*	50	0	Single Supply	LM2902	National
	500	50	—	—	—	100K	85*	0	Extended Temp LM224	MLM2902	Motorola
										LM2902	Raytheon
										LM2902	TI
8.0	500	75	10*	1*	0.6*	20K	70	0	Single Supply: I/O Operates to ground	XR3303	Exar
										µA3303C	Fairchild
										MC3303	Motorola
		100	—	1.5*	1*	25K	70	0	Quad 741	836C	Teledyne S
10.0	0.10	0.02	10	3*	7*	25K	70	0	JFET	TL084	TI
	500	50	10*	1*	0.6*	20K	70	0	Single Supply; I/O Operates to ground	XR3403	Exar
										µA3403	Fairchild
										MC3403	Motorola
										RC3403	**Raytheon (586)**
			—	1*	2*	15K	70	0	LM224 with improved output	**RV3403A**	**Raytheon (586)**
	600	300	—	3*	1*	15K	60	0	Quad 741	RC4136C	Raytheon
										RC4136C	TI
—	100	—	—	2.5*	0.5/20*	2K	—	0	Current Mirror, Single Supply	LM1900	† National
	200	—	—	2.5*	0.5/20*	1.2K	—	0	Current Mirror, Single Supply	LM2900	National
										LM3900	National
										LM2900	Raytheon
										LM3900	Raytheon
	300	—	—	4*	0.6*	1K	—	0	Current Mirror, Single Supply	µA3301C	Fairchild
										MC3301	Motorola
										RC3301	Raytheon
	300	—	—	2.5*	0.5/20*	1.2K	—	0	Current Mirror, Single Supply	LM3301	National
										LM3401	National
				5*	0.6*	1K	—	0	Current Mirror, Single Supply	µA3401C	Fairchild
										MC3401	Motorola
										CA3401	† RCA
										RC3401	Raytheon

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Phase Locked Loops/Synthesizers

Phase Locked Loop Circuits

Note: Stereo Decoders are listed under Consumer Circuits

Function	Device	Source	Line
Counter Logic Control			
	SP8790	Plessey	
Counter Control Logic (Use with MC12012 for high frequency programming)			
	MC12014	Motorola	
Crystal Oscillator (0.1 to 2.0 MHz)			
	MC12060	Motorola	10
	MC12560	† Motorola	
Crystal Oscillator (2 to 20 MHz)			
	MC12061	Motorola	
	MC12561	† Motorola	
Current Controlled Oscillator and Phase Comparator			
	HA-2820	† Harris	
	HA-2825	Harris	
Digital Mixer			
	MC12000	Motorola	20
Double Balanced Mixer			
	MC12002	Motorola	
	MC12502	† Motorola	
FSK Modulator/Demodulator			
	XR210	Exar	
	XR2211	† Exar	
	XR2211C	Exar	
	XR2211C	Raytheon	
	XR2211M	† Raytheon	
Offset Control System (for synthesizer tuned transceivers)			30
	MC12020	Motorola	
	MC12021	Motorola	
	MC12520	† Motorola	
	MC12521	Motorola	
Phase Comparator and Programmable Counter			
	MC14568BA	† Motorola	
	MC14568BC	Motorola	
Phase-Frequency Detector			
	11C44C	Fairchild	40
	11C44M	Fairchild	
	MC4044	Motorola	
	MC4344	† Motorola	
	MC12040	Motorola	
	MC12540	† Motorola	
Phase Locked Loop			
	XR215	Exar	
	NE564	Signetics	
Phase Locked Loop (CMOS)			
	F4046BC	Fairchild	50
	F4046BM	† Fairchild	
	SIL4046B	Mitel	
	MC14046BA	† Motorola	
	MC14046BM	Motorola	
	CD4046B	† RCA	
	CD4046BE	RCA	
	SCL4046B	† SSS	
	SCL4046BE	SSS	
	SCL4446	SSS	
	TF4046A/B	† TI	
	(Cont'd)		60

Phase Locked Loop Circuits (Cont'd)

Function	Device	Source	Line
Phase Locked Loop (CMOS) (Continued)			
	TP4046A/B	TI	
Phase Locked Loop Control (Oscillator, programmable divider, phase comparator)			
	SP8760	Plessey	
Phase Lock, Divider, Comparator			
	SP5228	Plessey	
Synthesizer Control Circuit (Internally programmed, to 40 channels)			70
	NC6400	Nitron	
	NC6401	Nitron	
Synthesizer (Programmable Divider, to 1021 channels, adder, phase comparator)			
	HCTR0320	Hughes	
Synthesizer, Citizen Band			
	HCTR0340	Hughes	
	HCTR0347	Hughes	
	MPS7139	Micro Power	80
	MPS7149	Micro Power	
	MC15104	Motorola	
	MC15106	Motorola	
	MC15109	Motorola	
	MC15112	Motorola	
	MM55104	National	
	MM55106	National	
	MM55114	National	
	MM55116	National	
	NC6402	Nitron	90
	MN6040	Panasonic	
	MN6040	Panasonic	
	SP8920	Plessey	
	SP8921	Plessey	
	SP8922	Plessey	
	SP8923	Plessey	
Synthesizer, Marine Radio, to 82 channels			
	NC6400	Nitron	
Synthesizer, T.V., to 98 channels			
	NC6410	Nitron	100
Synthesizer, Fixed or Programmable			
	CRC8100	Collins	
Synthesizer, Externally Programmable			
	NC6420	Nitron	
Synthesizer (Programmable Dividers, Phase Comparator)			
	S187	Siemens	
Tone Decoder			
	XR567	† Exar	
	XR567C	Exar	110
	XR2211	† Exar	
	XR2211C	Exar	
	LM567	† National	
	LM567C	National	
	XR2211C	Raytheon	
	XR2211M	† Raytheon	
	NE567	Signetics	
	SE567	† Signetics	
Dual Tone Decoder			
	XR2567	† Exar	
	(Cont'd)		120

Phase Locked Loop Circuits (Cont'd)

Function	Device	Source	Line
Dual Tone Decoder (Continued)			
	XR2567C	Exar	
	XR2567C	Raytheon	
	XR2567M	† Raytheon	
Tone Generator			
	FX205	CMA	
Two Modulus Prescaler ([5/6)			
	11C91C	Fairchild	130
	11C91M	† Fairchild	
	95H91C	Fairchild	
	95H91M	† Fairchild	
	SP8740	Plessey	
	SP8745	Plessey	
Two Modulus Prescaler ([6/7)			
	SP8741	Plessey	
	SP8746	Plessey	
Two Modulus Prescaler ([8/9)			
	SP8743	Plessey	140
Two Modulus Prescaler ([5/6, 10/11, 10/12)			
	MC12012	Motorola	
Two Modulus Prescaler ([10/11)			
	11C90C	Fairchild	
	11C90M	† Fairchild	
	95H90C	Fairchild	
	95H90M	† Fairchild	
	95H91C	Fairchild	
	MC12013	Motorola	
	MC12513	† Motorola	150
	SP8640	Plessey	
	SP8641	Plessey	
	SP8642	Plessey	
	SP8643	Plessey	
	SP8685	Plessey	
	SP8690	Plessey	
	SP8695	Plessey	
Two Modulus Prescaler ([248/256)			
	11C83	Fairchild	
Count Extender ([8, extends division ratio of a Two Modulus Prescaler while retaining the difference, ie [10/11 becomes [80/81)			160
	SP8794	Plessey	
	SP8794A	† Plessey	
Count Extender, (divide by 4, divide by 10/11 becomes divide by 40/41)		Plessey	
For other Prescalers see Digital-Special, Dividers			
VCO			
	11C58C	Fairchild	170
	MC1648	† Motorola	
	MC1658	Motorola	
	SP1648	Plessey	
	SP1658	Plessey	
	SN54LS324	† TI	
	SN74LS324	TI	
VCO-Function Generator			
	LM566	National	
	LM566C	† National	
	NE566	Signetics	
	(Cont'd)		180

† Military Temperature Range (−55°C to 125°C)

Phase Locked Loop Circuits (Cont'd)

Function	Device	Source	Line
VCO-Function Generator (Continued)			
	SE566	† Signetics	
VCO and Phase Comparator			
	XR2207	Exar	
	XR2207C	Exar	
	MLM565	Motorola	
	LM565	National	
	LM565C	† National	10
	XR2207C	Raytheon	
	XR2207M	† Raytheon	
	NE560	Signetics	
	NE561	Signetics	
	NE562	Signetics	
	NE565	Signetics	
	SE565	† Signetics	
	TA7133	Toshiba	
VCO-Waveform Generator			
	1453C	DDC	20
	XR205	Exar	
	XR2206	† Exar	
	XR2206C	Exar	
	1453M	† DDC	
	8038C	Intersil	
	8038M	† Intersil	
	LS8038C	Lithic Sys	
	LS8038M	† Lithic Sys	
VCO, Amplifier, Analog Multiplier			
	XRS200	Exar	30
	XR205	Exar	
VCO, Phase Comparator, Multiplier			
	SL651	Plessey	
VCO, Phase Comparator Multiplier, with Auxiliary Amplifier			
	SL650	† Plessey	
Dual VCO			
	11C24C	Fairchild	
	MC4024	Motorola	
	MC4324	† Motorola	40
	DM54LS124	† National	
	DM74LS124	National	
	SN54LS124	† TI	
	SN54S124	† TI	
	SN74LS124	TI	
	SN74S124	TI	
	SN54LS325	TI	
	SN74LS325	TI	
	SN54LS326	† TI	
	SN74LS326	TI	50
	SN54LS327	† TI	
	SN74LS327	TI	

Telecommunication Circuits

Function	Device	Source	Line
Baseband Modulator/Demodulator (50db carrier suppression)			
	SL1001	Plessey	
Baseband Channel Amplifier (24-27db amplifier)			
	SL1020	Plessey	

Telecommunication Circuits (Cont'd)

Function	Device	Source	Line
Coin box Circuit (Coin recognition for pay telephones)			60
	AY5-9300	GI	
Compander (Signal Compressor/Expander)			
	XR2216	Exar	
	LM2704	National	
	LM2705	National	
	LM2706	National	
	LM2707	National	70
	LS3704	National	
	LM3705	National	
	LM3706	National	
	LM3707	National	
	L150	SGS	
	NE570	Signetics	
	NE571	Signetics	
Companding Digital to Analog Converter			
	DAC-76	PMI	
Delta Modulation System (encodes and decodes audio signals)			80
	FX209	CMA	
Push Button Telephone Dialer Circuit (Converts push button inputs to pulses)			
	CRC8000	Collins	
	AY5-9100	GI	
	MM5395	National	
Binary to Pulse Train Converter (Phone pulse output)			
	MC14408	Motorola	90
	MC14409	Motorola	
Repertory Dialer (Stores ten telephone numbers)			
	AY5-9200	GI	
Clock Generator (for AY5-9100/9200)			
	AY5-9500	GI	
Tone Decoder (Three tone 8 combinations sequential code receiver)			
	FX307	CMA	
Tone Decoder (Operates from 0.01 Hz to 500 kHz)			100
	XR567	† Exar	
	XR567C	Exar	
	XR2211	† Exar	
	XR2211C	Exar	
	LM567	† National	
	LM567C	National	
	XR2211C	Raytheon	
	XR2211M	† Raytheon	
	NE567	Signetics	110
	SE567	† Signetics	
Dual Tone Decoder (Operates from 0.01 Hz to 500 kHz)			
	XR2567C	Raytheon	
	XR2567M	† Raytheon	
	XR2567	Exar	
Dual Tone Decoder			
	CRC8030	Collins	
	AY5-9800	GI	

Telecommunication Circuits (Cont'd)

Function	Device	Source	Line
Dual Tone Receiver Circuit (combine with filters for touch tone receiver			120
	AF104	National	
	AF106	National	
	AF107	National	
	AF108	National	
	AF110	National	
Gyrator			
	TCA580	Signetics	130
	AF120	National	
Relay Driver (For 48v telephone relays)			
	DS1686	† National	
	DS1687	† National	
	DS3686	National	
	DS3687	National	
Quad Tone Decoder			
	883-5	Beckman	
Encoder 2 of 8 keyboard to Binary Encoder (4 x 4 Key Input to 4 line output)			140
	MC14419	Motorola	
Bandpass (touchtone) Filters			
	882	† Beckman	
	883-X	† Beckman	
	AF101	National	
	AF102	National	
	AF103	National	
	AF111	National	
	AF112	National	
	AF113	National	150
	AF114	National	
Dual Tone Generator (Accepts 2 of 8 code 4 x 4 Key input, synthesizes 2 freq.)			
	S2559	**AMI**	**(400)**
	7206	Intersil	
	MK5085	Mostek	
	MK5086	Mostek	
	MC14410	Motorola	
Dual Tone Generator (Generates 12-16 tone pairs)			160
	AY3-9400	GI	
	AY3-9410	GI	
Dual Limiter (Touchtone Amplitude Limiter)			
	883-4	Beckman	
Modem, Frequency Division Multiplex Transmitter and Receiver			
	LM1823	National	
	LM1826	National	
Modem (Frequency-Shift Keying Modulator/ Demodulator- -600 bps)			170
	MC14412	Motorola	
Modem (For Serial Communications at up to 600 bps)			
	MC6860	Motorola	
Digital Filter Switch (Tone Decoder)			
	FX105	CMA	
Frequency Sensitive Switch (Provides two set points adjustable with external components.)			
	FX101	CMA	

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Telecommunication Circuits Timers

Telecommunication Circuits (Cont'd)

Function	Device	Source	Line
Frequency Sensitive Switch (Provides set points with widely adjustable hysteresis)	FX305	CMA	
Frequency Sensitive Switch (Provides two set points and three state outputs)	FX401	CMA	
Tone Operated Switch (Bistable tone operated switch)	FX501	CMA	10
Tone Operated Monostable Timer (Tone operated for remote switching)	FX601	CMA	
Tone Transmitter (Three tone sequential code transmitter)	FX207	CMA	
Tone Transceiver (Decodes and encodes 5 sequential tones)	FX407	CMA	20
	FX507	CMA	
Tone Transceiver Code Selector (Programs 3 codes for FX407/507)	FX707	CMA	
Tone Transceiver (Single tone transmitter-receiver-simplex.)	FX107	CMA	
Cross Point Array (Double 4 x 4 switch matrix)	MC3466	Motorola	30
	RC4444	Raytheon	
	RM4444	Raytheon	
Crosspoint Array (4 x 4 switch matrix)	TA6249	RCA	
Crosspoint Array (8 x 2 switch matrix)	SD5300	Signetics	

Timers

Function	Device	Source	Line
Timer	NE555	† AMD	40
	SE555	AMD	
	XR555C	Exar	
	μA555C	Fairchild	
	NE555	Intersil	
	SE555	† Intersil	
	LS555N	Lithic Sys	
	LS555S	† Lithic Sys	
	MCC555	Micro Comp	
	MC1455	Motorola	
	MC1555	† Motorola	
	LM555C	National	50
	LM555M	† National	
	RC555	Raytheon	
	RM555	† Raytheon	
	CA555	† RCA	
	CA555C	RCA	
	NE555	Signetics	
	SE555	† Signetics	
	SG555	† Silicon G	
	SG555C	Silicon G	
	ULN-3303	Sprague	60
	ULN-3304	Sprague	

(Cont'd)

Timers (Cont'd)

Function	Device	Source	Line
Timer (Continued)	355A/C	Teledyne S	
	355B/M	† Teledyne S	
	SE555	† TI	
	NE555	TI	
Timer, Adjustable Threshold	MC1422	Motorola	
Timer, (high voltage logic element)	SP533A	Plessey	70
	SP533B	Plessey	
Timer, Internal Current Source	XR320	Exar	
Timer, Low Power (Supply 3v)	SN76812	TI	
Timer, Precision	ZN1034E	Ferranti	
	LM122	† National	
	LM222	National	80
	LM322	National	
	LM2905	National	
	LM3905	National	
Timer Programmable (includes a counter for long time delays) Binary Control	XR2240C	Exar	
	XR2240M	† Exar	
	μA2240	Fairchild	
	8240	Intersil	
	MC14541A	† Motorola	90
	MC14541C	Motorola	
Timer, Programmable (includes counter) Decimal Control	XR2250C	Exar	
	XR2250M	† Exar	
	8250	Intersil	
Timer, Programmable (includes counter) Hours/Minutes/Seconds Control	8260	Intersil	
Dual Timer (dual 555)	NE556	AMD	100
	SE556	† AMD	
	XR556C	Exar	
	XR556M	† Exar	
	μA556	Fairchild	
	NE556	Intersil	
	SE556	† Intersil	
	MC3456	Motorola	
	MC3556	† Motorola	
	LM556	† National	110
	LM556C	National	
	RC556	Raytheon	
	RM556	† Raytheon	
	556	Teledyne S	
	NE556	Signetics	
	SE556	† Signetics	
	SG556	† Silicon G	
	SG556C	Silicon G	
Dual Timer (dual 555), pinout variations	XR2556C	Exar	120
	XR2556M	† Exar	
	LS555-2	Lithic Sys	

(Cont'd)

Timers (Cont'd)

Function	Device	Source	Line
Dual Timer (dual 555), pinout variations (Continued)	D555	Teledyne S	
Dual Set Point Timer (includes timer, selectable time range)	**DF215**	**Siliconix (601)**	
Universal Timer (includes two 4-digit counters, comparator, clock oscillator and divider)	MM5865	National	130
Dual Monostable Timer	FX109	CMA	
Quad Timer, Current Sink Output	NE553	Signetics	
	SE553	† Signetics	
Quad Timer, Current Source Output	NE554	Signetics	
	SE554	† Signetics	140
Tone Triggered Timer	FX601	CMA	
Watch Circuits: See Linear-Consumer Circuits, Watches; Stopwatches			

† Military Temperature Range (−55°C to 125°C)

LINEAR—Voltage Regulators

Fixed, Positive

Output Voltage	Output Current	Device	Source
2.6	100 ma	μA78L26C	Fairchild
		MC78L02C	Motorola
		μA78L02C	Signetics
		μA78L02C	TI
5	100 ma	μA78L05C	Fairchild
		MC78L05	Motorola
		LM140LA-5	National
		LM240LA-5	National
		LM340LA-5	National
		LM78L05C	National
		μA78L05C	Signetics
		μA78L05C	TI
	200 ma	MLM109G	Motorola
		MLM209G	Motorola
		MLM309G	Motorola
		LM109H	† National
		LM209H	National
		LM309H	National
		LM342-5	National
		SFC2109	† NPC
		SFC2209	NPC
		SFC2309	NPC
		SL78L05	Plessey
		TBA625A	Plessey
		LM109H	† Raytheon
		LM209H	Raytheon
		LM309H	Raytheon
		LM109DB	† Signetics
		LM209DB	Signetics
		LM309DB	Signetics
		SG109T	† Silicon G
		SG209T	Silicon G
		SG309T	Silicon G
		LM109	† TI
		LM209	TI
		LM309	TI
	500 ma	805-V5	† Beckman
		μA78C05C	Fairchild
		μA78M05C	Fairchild
		μA78M05M	† Fairchild
		MC7705C	Motorola
		MC78M05C	Motorola
		LM341-5	National
		SL78M05	Plessey
		μA78M05	† Signetics
		μA78M05C	Signetics
		μA78M05C	TI
		μA78M05M	† TI
	600 ma	L005T1	SGS
	750 ma	809-V5	† Beckman
	850 ma	L129	SGS
	1 a	μA109M	† Fairchild
		μA209M	Fairchild
		μA309C	Fairchild
		μA7805C	Fairchild
		μA7805M	† Fairchild
		MLM109	† Motorola
		MLM209K	Motorola
		MLM309	Motorola
	(Cont'd)		

Fixed, Positive (Cont'd)

Output Voltage	Output Current	Device	Source
5	1 a	(Cont'd)	
		MC7805C	Motorola
		LM109K	† National
		LM209K	National
		LM309K	National
		LM7805	National
		SFC2109M	NPC
		SL7805	Plessey
		LM109K	† Raytheon
		LM209K	Raytheon
		LM309K	Raytheon
		μA7805	† Signetics
		μA7805C	Signetics
		μA78HV05	Signetics
		LM109DA	† Signetics
		LM209DA	Signetics
		LM309DA	Signetics
		LM340-5	Signetics
		SG109K	† Silicon G
		SG209K	Silicon G
		SG309K	Silicon G
		SG7805K	† Silicon G
		SG7805CK	Silicon G
		μA7805M	† TI
	1.5 a	LM340-5	National
		LAS1505	PMC
	3 a	SH0323	Fairchild
		LAS1405	PMC
		SI3554	Sanken
		SG123	† Silicon G
		SG223	Silicon G
		SG323	Silicon G
		LM123	† National
		LM223	National
		LM323	National
	5 a	μA78H05	Fairchild
		42050-055	Micropac
	10 a	42050-510	Micropac
6	100 ma	LM140LA-6	National
		LM240LA-6	National
		LM340LA-6	National
		LM78L06C	National
	200 ma	PC521	† GI
		LM342-6	National
		SL78L06	Plessey
		SG7806T	† Silicon G
		SG7806CT	Silicon G
	500 ma	805-V6	† Beckman
		μA78C08C	National
		μA78M06C	Fairchild
		μA78M06M	† Fairchild
		MC7706C	Motorola
		MC78M06C	Motorola
		LM341-6	National
		SL78M06	Plessey
		μA78M06C	Signetics
		μA78M06M	† Signetics
		μA78M06C	TI
		μA78M06M	† TI
	(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Voltage Regulators (Cont'd)

Output Voltage	Output Current	Device	Source
Fixed, Positive (Cont'd)			
6	500 ma	(Cont'd)	
	750 ma	809-V6	† Beckman
	1 a	µA7806C	Fairchild
		µA7806M	† Fairchild
		MC7806C	Motorola
		LM7806	National
		SL7806	Plessey
		SG7806CK	Silicon G
		SG7806K	† Silicon G
		µA78HV06	Signetics
		µA7806	† Signetics
		µA7806C	Signetics
		LM340-6	Signetics
		µA7806C	TI
		µA7806M	† TI
	1.5 a	LM340-6	National
		LAS1506	PMC
	2 a	CJSE017	Solitron
		CJSE019	Solitron
		CJSE021	Solitron
	3 a	LAS1406	PMC
	10 a	42050-610	Micropac
6.2	100 ma	µA78L62C	Fairchild
		µA78L06C	Signetics
		µA78L06C	TI
7	10 a	42050-710	Micropac
8	100 ma	µA78L08C	Fairchild
		MC78L08	Motorola
		LM140LA-8	† National
		LM240LA-8	National
		LM340LA-8	National
		LM78L08C	National
		µA78L08	TI
	200 ma	LM342-8	National
		SL78L08	Plessey
		SG7808T	† Silicon G
		SG7808CT	Silicon G
	500 ma	µA78C08C	Fairchild
		µA78M08C	Fairchild
		µA78M08M	† Fairchild
		MC7708C	Motorola
		MC78M08C	Motorola
		LM341-8	National
		SL78M08	Plessey
		µA78M08C	Signetics
		µA78M08M	† Signetics
		µA78M08C	TI
		µA78M08M	† TI
	1 a	µA7808C	Fairchild
		µA7808M	† Fairchild
		MC7808C	Motorola
		LM7808	National
		µA7808	† Signetics
		µA7808C	Signetics
		µA78HV08	Signetics
		LM340-8	Signetics
		SG7808CK	Silicon G
		SG7808K	† Silicon G
	(Cont'd)		

Output Voltage	Output Current	Device	Source
Fixed, Positive (Cont'd)			
8	1 a	(Cont'd)	
		µA7808M	† TI
		µA7808C	TI
	1.5 a	LM340-8	National
		LAS1508	PMC
	3 a	LAS1408	PMC
	10 a	42050-810	Micropac
	100 ma	µA78C82C	Fairchild
		µA78L82C	Fairchild
	200 ma	TBA435	Plessey
	1 a	µA7885	Fairchild
		µA7885C	TI
		µA7885M	† TI
9	100 ma	µA78L09C	Fairchild
	500 ma	801-V9	† Beckman
	750 ma	809-V9	† Beckman
10	100 ma	LM140LA-10	† National
		LM240LA-10	National
		LM340LA-10	National
		LM78L10C	National
	200 ma	LM342-10	National
	1 a	µA7810	TI
	1.5 a	LM340-10	National
		LM7810	National
		LAS1510	PMC
	3 a	LAS1410	PMC
	9 a	42050-109	Micropac
12	50 ma	829B	† Teledyne S
		829C	Teledyne S
	100 ma	µA78L12C	Fairchild
		MC78L12	Motorola
		LM140LA-12	† National
		LM240LA-12	National
		LM340LA-12	National
		LM78L12C	National
		78L12C	Signetics
		µA78L12C	TI
	200 ma	PC501	† GI
		LM342-12	National
		SL78L12	Plessey
		TBA625B	Plessey
		SG7812CT	Silicon G
		SG7812T	† Silicon G
	500 ma	801-V12	† Beckman
		µA78C12C	Fairchild
		µA78M12C	Fairchild
		µA78M12M	† Fairchild
		MC7712C	Motorola
		MC78M12C	Motorola
		LM341-12	National
		SL78M12	Plessey
		L036T1	SGS
		µA78M12C	Signetics
		µA78M12M	† Signetics
		µA78M12M	† TI
	(Cont'd)		

† Military Temperature Range (−55°C to 125°C) Regulator Sections: Fixed—Positive, Negative, Dual; Adjustable—Positive, Negative, Dual

LINEAR—Voltage Regulators (Cont'd)

Output Voltage	Output Current	Device	Source
Fixed, Positive (Cont'd)			
12	500 ma	(Cont'd)	
		μA78M12C	TI
	720 ma	L130	SGS
	750 ma	809-V12	† Beckman
	1 a	μA7812C	Fairchild
		μA7812M	† Fairchild
		MC7812C	Motorola
		LM7812	National
		SL7812	Plessey
		SI3120E	Sanken
		μA7812	† Signetics
		μA7812C	Signetics
		μA78HV12	Signetics
		SG7812K	† Silicon G
		SG7812CK	Silicon G
		μA7812C	TI
		μA7812M	† TI
	1.5 a	LM340-12	National
		LAS1512	PMC
	3 a	LAS1412	PMC
	5 a	μA78H12	Fairchild
	8 a	42050-128	Micropac
14	8 a	42050-148	Micropac
15	400 μa	L037T1	SGS
	50 ma	830B	† Teledyne S
		830C	Teledyne S
	100 ma	μA78L15C	Fairchild
		MC78L15	Motorola
		LM140LA-15	† National
		LM240LA-15	National
		LM340LA-15	National
		LM78L15C	National
		78L15C	Signetics
		μA78L15C	TI
	200 ma	LM342-15	National
		SL78L15	Plessey
		TBA625C	Plessey
		SG7815CT	Silicon G
		SG7815T	† Silicon G
	500 ma	801-V15	† Beckman
		μA78C15	Fairchild
		μA78M15C	Fairchild
		μA78M15M	† Fairchild
		MC7715C	Motorola
		MC78M15C	Motorola
		LM341-15	National
		SL78M15	Plessey
		μA78M15	† Signetics
		μA78M15C	Signetics
		μA78M15C	TI
		μA78M15M	† TI
	600 ma	L131	SGS
	750 ma	809-V15	† Beckman
	1 a	μA7815C	Fairchild
		μA7815M	† Fairchild
		MC7815C	Motorola
	(Cont'd)		

Output Voltage	Output Current	Device	Source
Fixed, Positive (Cont'd)			
15	1 a	(Cont'd)	
		LM340-15	National
		LM7815	National
		SL7815	Plessey
		SI3150E	Sanken
		μA7815	† Signetics
		μA7815C	Signetics
		μA78HV15	Signetics
		LM340-15	Signetics
		SG7815CK	Silicon G
		SG7815K	† Silicon G
		μA7815C	TI
		μA7815M	† TI
	1.5 a	L340-15	National
		LAS1515	PMC
	2 a	CJSE001	Solitron
		CJSE003	Solitron
		CJSE005	Solitron
	3 a	LAS1415	PMC
	8 a	42050-158	Micropac
16	8 a	42050-168	Micropac
17	500 ma	μA78C17C	Fairchild
18	100 ma	μA78L18	Fairchild
		MC78L18	Motorola
		LM140LA-18	† National
		LM240LA-18	National
		LM340LA-18	National
		LM78L18C	National
	200 ma	LM342-18	National
		SL78L18	Plessey
		SG7818CT	Silicon G
		SG7818T	† Silicon G
	500 ma	801-V18	† Beckman
		μA78C18C	Fairchild
		MC7718C	Motorola
		MC78M18C	Motorola
		LM341-18	National
	1 a	μA7818C	Fairchild
		μA7818M	† Fairchild
		MC7818C	Motorola
		LM340-18	National
		LM7818	National
		SL7818	Plessey
		LM340-18	Signetics
		μA7818	† Signetics
		μA7818C	Signetics
		μA78HV18	Signetics
		SG7818CK	Silicon G
		SG7818K	† Silicon G
		μA7818M	† TI
		μA7818C	TI
	1.5 a	LAS1515	PMC
	8 a	42050-188	Micropac
20	200 ma	SL78L20	Plessey
	500 ma	μA78C20C	Fairchild
		μA78M20C	Fairchild
		μA78M20M	† Fairchild
	(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Voltage Regulators (Cont'd)

Output Voltage	Output Current	Device	Source
Fixed, Positive (Cont'd)			
20	500 ma	(Cont'd)	
		MC7720C	Motorola
		MC78M20C	Motorola
		SL78M20	Plessey
		μA78M20C	Signetics
		μA78M20M	† Signetics
		μA78M20C	TI
		μA78M20M	† TI
	1.5 a	LAS1520	PMC
	2 a	CJSE009	Solitron
		CJSE011	Solitron
		CJSE013	Solitron
	8 a	42050-208	Micropac
22	4 a	42050-224	Micropac
24	100 ma	μA78L24	Fairchild
		MC78L24	Motorola
		LM140LA-24	† National
		LM240LA-24	National
		LM340LA-24	National
		LM78L24C	National
	200 ma	NC512	† GI
		PC502	† GI
		PC512	† GI
		LM342-24	National
		SL78L24	Plessey
		SG7824T	† Silicon G
		SG7824CT	Silicon G
	500 ma	μA78C24C	Fairchild
		μA78M24C	Fairchild
		μA78M24M	† Fairchild
		MC7724C	Motorola
		MC78M24C	Motorola
		LM341-24	National
		μA78M24	† Signetics
		μA78M24C	Signetics
		μA78M24C	TI
		μA78M24M	† TI
	1 a	μA7824C	Fairchild
		μA7842M	† Fairchild
		MC7824C	Motorola
		LM340-24	National
		LM7824	National
		SL7824	Plessey
		SI3240E	Sanken
		μA7824	† Signetics
		μA7824C	Signetics
		μA78HV24	Signetics
		LM340-24	Signetics
		SG7824K	† Silicon G
		SG7824CK	Silicon G
		μA7824C	TI
		μA7824M	† TI
	1.5 a	LAS1524	PMC
	4 a	42050-244	Micropac
26	4 a	42050-264	Micropac
28	1.5 a	LAS1528	PMC
	(Cont'd)		

Output Voltage	Output Current	Device	Source
Fixed, Positive (Cont'd)			
28	1.5 a	(Cont'd)	
	4 a	42050-284	Micropac
30	200 ma	SL78L30	Plessey
	500 ma	SL78M30	Plessey
	1a	SL7830	Plessey
	4 a	42050-304	Micropac
31	Shunt	TBA271A	SGS
		TAA550	Signetics
32	Shunt	AN155	Panasonic
	4 a	42050-324	Micropac
33	Shunt	TBA271B	SGS
		TAA550	Signetics
34	4 a	42050-344	Micropac
35	Shunt	TBA271C	SGS
		TAA550	Signetics
36	4 a	42050-364	Micropac
Fixed, Negative			
2	1 a	MC7902C	Motorola
	1.5 a	PMC18K-2	PMC
	2 a	μA79E02	† Fairchild
		μA79E02C	Fairchild
3	100 ma	MC79L03	Motorola
4	1 a	MC7904C	Motorola
5	100 ma	MC79L05	Motorola
	500 ma	855-V5	† Beckman
		μA79M05C	Fairchild
		LM120H05	† National
		LM220H05	National
		LM320H05	National
		LM320M05	National
		SG120-05T	† Silicon G
		SG220-05T	Silicon G
		SG320-05T	Silicon G
		μA79M05	TI
	750 ma	859-V5	† Beckman
	1.5 a	μA7905C	Fairchild
		LM7905	National
		MC7905C	Motorola
		LM120K05	† National
		LM220K05	National
		LM320K05	National
		LM320T05	National
		LAS1805	PMC
		SG120-05K	† Silicon G
		SG220-05K	Silicon G
		SG320-05K	Silicon G
		μA7905C	TI
		μA7905M	† TI
	2 a	μA79E05	† Fairchild
		μA79E05C	Fairchild
	3 a	LM145K5.0	† National
		LM245K5.0	National
	(Cont'd)		

† Military Temperature Range (−55°C to 125°C) Regulator Sections: Fixed—Positive, Negative, Dual; Adjustable—Positive, Negative, Dual

LINEAR—Voltage Regulators (Cont'd)

Output Voltage	Output Current	Device	Source
Fixed, Negative (Cont'd)			
5	3 a	(Cont'd)	
		LM345K5.0	National
	5 a	42051-055	Micropac
5.2	500 ma	LM120H5.2	† National
		LM220H5.2	National
		LM320H5.2	National
		LM320M5.2	National
		SG120-5.2T	† Silicon G
		SG220-5.2T	Silicon G
		SG320-5.2T	Silicon G
	1 a	MC7952C	Motorola
		LM7905.2	National
		SG120-5.2K	† Silicon G
		SG220-5.2K	Silicon G
		SG320-5.2K	Silicon G
	1.5 a	LM120K5.2	† National
		LM220K5.2	National
		LM320K5.2	National
		LM320T5.2	National
		LAS18052	PMC
	3 a	LM14K5.2	† National
		LM245K5.2	National
		LM345K5.2	National
6	200 ma	PC523	GI
	500 ma	855-V6	† Beckman
		μA79M06C	Fairchild
		LM120H06	† National
		LM220H06	National
		LM320H06	National
		LM320M06	National
		μA79M06	TI
	750 ma	859-V6	† Beckman
	1.5 a	μA7906C	Fairchild
		MC7906C	Motorola
		LM7906	National
		μA7906	TI
		LM120K06	† National
		LM220K06	National
		LM320K06	National
		LM320T06	National
		LAS1806	PMC
		μA7906C	TI
		μA7908M	† TI
	2 a	CJSE018	Solitron
		CJSE020	Solitron
	5 a	42051-065	Micropac
7	5 a	42051-075	Micropac
8	500 ma	μA79M08C	Fairchild
		LM120H08	† National
		LM220H08	National
		LM320H08	National
		LM320M08	National
		μA79M08	TI
		μA7908C	Fairchild
	1.5 a	μA7908C	Fairchild
		MC7908C	Motorola
		LM7908	National
	(Cont'd)		

Output Voltage	Output Current	Device	Source
Fixed, Negative (Cont'd)			
8	1.5 a	(Cont'd)	
		LM120K08	† National
		LM220K08	National
		LM320K08	National
		LM320T08	National
		LAS1808	PMC
		μA7908C	TI
		μA7908M	† TI
	5 a	42051-085	Micropac
9	200 ma	LM120H09	† National
		LM220H09	National
		LM320H09	National
	500 ma	851-V9	† Beckman
		LM320M09	National
	750 ma	859-V9	† Beckman
	1 a	LM120K09	† National
		LM220K09	National
		LM320K09	National
		LM320T09	National
	1.5 a	42051-095	Micropac
		LM7909	National
10	1.5 a	LAS1810	PMC
	5 a	42051-105	Micropac
12	100 ma	MC79L12	Motorola
	200 ma	PC503	† GI
		LM120H12	† National
		LM220H12	National
		LM320H12	National
		SG120-12T	† Silicon G
		SG220-12T	Silicon G
		SG320-12T	Silicon G
	500 ma	851-V12	† Beckman
		μA79M12C	Fairchild
		LM320M12	National
		μA79M12	TI
	750 ma	859-V12	† Beckman
	1 a	LM120K12	† National
		LM220K12	National
		LM320K12	National
		LM320T12	National
		LM7912	National
		SG120-12K	† Silicon G
		SG220-12K	Silicon G
		SG320-12K	Silicon G
	1.5 a	μA7912C	Fairchild
		MC7912C	Motorola
		LAS1812	PMC
		μA7912C	TI
		μA7912M	† TI
	4 a	42051-124	Micropac
14	4 a	42051-144	Micropac
15	100 ma	MC79L15	Motorola
	200 ma	LM120H15	† National
		LM220H15	National
		LM320H15	National
	(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Voltage Regulators (Cont'd)

Output Voltage	Output Current	Device	Source
Fixed, Negative (Cont'd)			
15	200 ma	(Cont'd)	
		SG120-15T	† Silicon G
		SG220-15T	Silicon G
		SG320-15T	Silicon G
	500 ma	851-V15	† Beckman
		μA79M15C	Fairchild
		LM320M15	National
		μA79M15	TI
	750 ma	859-V15	† Beckman
	1 a	LM120K15	† National
		LM220K15	National
		LM320K15	National
		LM320T15	National
		LM7915	National
		SG120-15K	† Silicon G
		SG220-15K	Silicon G
		SG320-15K	Silicon G
	1.5 a	μA7915C	Fairchild
		μA7915C	Motorola
		LAS7815	PMC
		μA7915C	TI
		μA7915	† TI
	2 a	CJSE002	Solitron
		CJSE004	Solitron
		CJSE006	Solitron
	4 a	42051-154	Micropac
16	4 a	42051-164	Micropac
18	100 ma	MC79L18	Motorola
	200 ma	LM120H18	† National
		LM220H18	National
		LM320H18	National
	500 ma	LM320M18	National
	1 a	LM120K18	† National
		LM220K18	National
		LM320K18	National
		LM320T18	National
		LM7918	National
	1.5 a	μA7918C	Fairchild
		MC7918C	Motorola
		LAS1818	PMC
		μA7918C	TI
		μA7918M	† TI
	4 a	42051-184	Micropac
20	500 ma	μA79M20C	Fairchild
		μA79M20	TI
	1.5 a	LAS1820	PMC
	2 a	CJSE010	Solitron
		CJSE012	Solitron
		CJSE014	Solitron
	3 a	42051-204	Micropac
22	3 a	42051-223	Micropac
24	100 ma	MC79L24	Motorola
	200 ma	PC514	GI
		LM120H24	† National
	(Cont'd)		

Output Voltage	Output Current	Device	Source
Fixed, Negative (Cont'd)			
24	200 ma	(Cont'd)	
		LM220H24	National
		LM320H24	National
	500 ma	μA79M24C	Fairchild
		LM320M24	National
		μA79M24	TI
	1 a	LM120K24	† National
		LM220K24	National
		LM320K24	National
		LM320T24	National
		LM7924	National
	1.5 a	μA7924C	Fairchild
		MC7924C	Motorola
		LAS1824	PMC
		μA7924C	TI
		μA7924M	† TI
	3 a	42051-243	Micropac
26	3 a	42051-263	Micropac
28	1.5 a	LAS1828	PMC
	3 a	42051-283	Micropac
30	3 a	42051-303	Micropac
31	Shunt	TBA271A	SGS
		TAA550	Signetics
32	Shunt	AN155	Panasonic
	3 a	42051-323	Micropac
33	Shunt	TBA271B	SGS
		TAA550	Signetics
34	3 a	42051-343	Micropac
35	Shunt	TBA271C	SGS
		TAA550	Signetics
36	3 a	42051-363	Micropac
Fixed, Dual			
±6	5 a	42051	Micropac
±12	100 ma	LM126	† National
		LM226	National
		LM326	National
	300 ma	843-V12	Beckman
-12,5	100 ma	LM127	† National
		LM227	National
		LM327	National
±15	100 ma	XR1468	Exar
		XR1568	† Exar
		XR4195	Exar
		MC1468	Motorola
		MC1568	† Motorola
		LM125	† National
		LM225	National
		LM325	National
		RC4195	**Raytheon (596)**
		RM4195	**† Raytheon (596)**
		SG1468	Silicon G
		SG1568	† Silicon G
		SG1501	† Silicon G
	(Cont'd)		

† Military Temperature Range (−55°C to 125°C) Regulator Sections: Fixed—Positive, Negative, Dual; Adjustable—Positive, Negative, Dual

LINEAR—Voltage Regulators (Cont'd)

Output Voltage	Output Current	Device	Source
Fixed, Dual (Cont'd)			
±15	100 ma	(Cont'd)	
		SG2501	Silicon G
		SG3501	Silicon G
		SG4501	Silicon G
	200 ma	SG1501A	† Silicon G
		SG2501A	Silicon G
		SG3501A	Silicon G
	300 ma	834-V15	† Beckman

Output Voltage	Output Current	Device	Source
Fixed, Dual			

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Voltage Regulators

Adjustable, Positive

See also Regulator, Switching under Linear-Other Devices

Output Voltage Hi	Output Voltage Low	Output Current	Device	Source
7	1	50 ma	NC520	† GI
		200 ma	NC521	† GI
9	3	500 ma	806	† Beckman
16	4	150 ma	NC109T	GI
20	2	20 ma	LM300	Intersil
			LM300	National
			SFC2300	NPC
			SG300	Silicon G
	10	800 ma	NC562	† GI
21	9	500 ma	802	† Beckman
26	1.8	12 ma	CA3085	† RCA
30	3	Shunt	TL430	TI
	4.5	12 ma	LM305	AMD
			μA305C	Fairchild
			305	Intersil
			MLM305	Motorola
			LM305	National
			LM305	Raytheon
			SG305	Silicon G
			LM305	TI
	2	20 ma	100	† Intersil
			200	Intersil
			LM100	† National
			LM200	National
			SFC2100	† NPC
			SFC2200	NPC
			SG100	† Silicon G
			SG200	Silicon G
	5	500 ma	μA78MG	Fairchild
		1 a	μA78G	Fairchild
	4	1.5 a	LAS15U	PMC
	2.6	3 a	LAS14U	PMC
	5	5 a	μA78HG	Fairchild
32	2.5	200 ma	MC1469G	Motorola
		500 ma	MC1469R	Motorola
			TA7184	Toshiba
	20	500 ma	804	† Beckman
35	2	4 a	MPC1000	Motorola
36	1.7	100 ma	CA3085A	† RCA
37	3	2 ma	NE550A	Signetics
	5	25 ma	μA376C	Fairchild
			LM376	National
			LM376	Teledyne S
			LM376	TI
		50 ma	SE550	† Signetics
	2	150 ma	723	† AMD
			723C	AMD
			μA723C	Fairchild
			μA723M	† Fairchild

(Cont'd)

Adjustable, Positive (Cont'd)

Output Voltage Hi	Output Voltage Low	Output Current	Device	Source
37	2	150 ma	(Cont'd)	
			HA17723	Hitachi
			723	† Intersil
			723C	Intersil
			MC1723	† Motorola
			MC1723C	Motorola
			LM723	† National
			LM723C	National
			SFC2723C	† NPC
			SFC2723EC	NPC
			CA723	† RCA
			CA723C	RCA
			RC723	Raytheon
			RM723	† Raytheon
			μA723	† Signetics
			μA723C	Signetics
			SG723	† Silicon G
			SG723C	Silicon G
			723BE	† Teledyne S
			723CE	Teledyne S
			823BE	† Teledyne S
			TL1723	Telefunken
			TL3723	Telefunken
			μA723C	TI
			μA723M	† TI
	2.5	200 ma	MC1561G	† Motorola
			MC1569G	† Motorola
		500 ma	MC1561R	† Motorola
			MC1569R	† Motorola
	1.2	1.5 a	LM117	† National
			LM217	National
			LM317	National
			LM117	† TI
			LM217	TI
			LM317	TI
38	2	150 ma	LAS723	PMC
			LAS3000	PMC
	8	250 ma	NC501	† GI
			NC530	† GI
			NC531	† GI
			NC511	† GI
			PC511	† GI
	12	625 ma	NC581	† GI
	13	250 ma	NC572	† GI
40	4.5	12 ma	LM105	AMD
			LM205	AMD
			μA105M	† Fairchild
			105	† Intersil
			205	Intersil
			MLM105	† Motorola
			MLM205	Motorola
			LM105	† National
			LM205	National
			SFC2105	† NPC
			SFC2205	NPC
			LM105	† Raytheon
			LM205	Raytheon
			SG105	† Silicon G

(Cont'd)

† Military Temperature Range (−55°C to 125°C) Regulator Sections: Fixed—Positive, Negative, Dual; Adjustable—Positive, Negative, Dual

LINEAR—Voltage Regulators (Cont'd)

Output Voltage Hi	Output Voltage Low	Output Current	Device	Source
Adjustable, Positive (Cont'd)				
40	4.5	12 ma	(Cont'd)	
			SG205	Silicon G
			LM105	† Teledyne S
			LM205	Teledyne S
			LM105	† TI
			LM205	TI
		45 ma	LM305A	AMD
			μA305AC	Fairchild
			305A	Intersil
			LM305A	National
			SFC2305	NPC
			SG305A	Silicon G
			LM305A	Raytheon
			LM305A	Teledyne S
			LM305A	TI
	2	50 ma	NE550	Signetics
		150 ma	SE550L	† Signetics
			823AE	† Teledyne S
46	1.7	100 ma	CA3085B	† RCA
48	2	150 ma	LAS7238	PMC
			LAS1100	PMC
56	8	1 a	CJCA001	Solitron
			CJCA007	Solitron
1000	0	100 ma	MC1466	Motorola
			MC1566	† Motorola
Adjustable, Negative				
7	1	200 ma	NC623	† GI
9	3	500 ma	856	† Beckman
21	9	500 ma	852	† Beckman
30	.035	20 ma	μA304C	Fairchild
			MLM304G	Motorola
			LM304	National
			LM304	Raytheon
			SG304	Silicon G
			LM304	Teledyne S
			LM304	TI
	2.2	500 ma	μA79MG	Fairchild
		1 a	μA79G	Fairchild
	2.6	1.5 a	LAS18U	PMC
	4	5 a	MPC900	Motorola
32	3.8	200 ma	MC1463G	Motorola
			MC1463R	Motorola
		500 ma	MC1463R	Motorola
			TA7085	Toshiba
	20	500 ma	854	† Beckman
37	2	50 ma	SG1511	† Silicon G
			SG3511	Silicon G
	3.6	200 ma	MC1563G	† Motorola
		500 ma	MC1563R	† Motorola
38	8	250 ma	NC503	GI
			NC513	GI
			PC513	GI
			NC583	† GI
40	.015	20 ma	μA104M	† Fairchild
			MLM104G	† Motorola
			MLM204G	Motorola
			LM104	† National
			LM204	National
			SFC2104	† NPC
			SFC2204	NPC
			LM104	† Raytheon
			LM204	Raytheon
			SG104	† Silicon G
			SG204	Silicon G
			SG304	Silicon G
			LM104H	† Teledyne S
			LM204H	Teledyne S
			LM104	† TI
			LM204	TI
56	8	1 a	CJCA002	Solitron
			CJCA008	Solitron
Adjustable, Dual				
±20	±8	100 ma	XR1468	Exar
			XR1568	† Exar
			MC1468L	Motorola
			MC1568L	† Motorola
			SG1468J	Silicon G
			SG1568J	† Silicon G
	±14.5	100 ma	MC1568R	† Motorola
			MC1468R	Motorola
			SG1468T	Silicon G
			SG1568T	† Silicon G
±23	±8	200 ma	SG3501A	Silicon G
			SG1501A	† Silicon G
			SG2501A	Silicon G
	±10	100 ma	SG1501	† Silicon G
			SG2501	Silicon G
			SG3501	Silicon G
			SG4501	Silicon G
			SG3502	Silicon G
			SG1502	† Silicon G
			SG2502	Silicon G
±27	±8	100 ma	LM128	† National
			LM228	National
			LM328	National
±32	±.05	100 ma	XR4194CN	Exar
			RC4194D	**Raytheon (594)**
		200 ma	XR4194CK	Exar
			RC4194TK	**Raytheon (594)**
±42		100 ma	XR4194M	† Exar
			RM4194D	**† Raytheon (594)**
		200 ma	XR4194MK	† Exar
			RM4194TK	**† Raytheon (594)**

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Other Devices

Function	Device	Source	Line
Other Linear Devices			
AC Amplifier, Quad, Single Supply	CA3048	RCA	
AC Detector (Detects presence or absence of ac signals, includes adjustable threshold and time delay.)	3050	Intech	
Active Filters	881	Beckman	
	UAF21	Burr-Brown	10
	UAF21H	† Burr-Brown	
	UAF25	Burr-Brown	
	UAF25H	† Burr-Brown	
	UAF31	Burr-Brown	
	UAF41	Burr-Brown	
	FLT-U2	Datel	
	CH1290	Cermetek	
	8681	DDC	
	AF100	† National	
Alarms Circuits, Triple Alert/Alarm (Each circuit has two inputs, when the first one is low an open collector LED driver is turned on. When the second one is low -independent of the first the output is flashed at an adjustable rate).	3020	Intech	20
Alarm Circuits, Temperature	3030	Intech	
Alarm Circuits, Tone Alarm (Comparator with ac output)	3010	Intech	30
Amplifiers: See Linear-Amplifiers, Special Purpose			
Amplifier-Detector (for firing SCR's or operating relays	ULN-2301	Sprague	
Amplifier-SCR firing Circuit	ULN-2300	Sprague	
Analog-Digital Control Circuit (Wide bandwidth op amp and high speed, dual threshold comparator)	MC1407	Motorola	40
	MC1507	† Motorola	
Analog to Digital Converter and vice versa (Delta Modulation System encodes and decodes audio signals at a 1-125 (kHz sample rate)	FX209	CMA	
Analog Shift Register, 130x2, with storage (See also Serial Analog Delay, Bucket Brigade below)	CCD311	Fairchild	50
Analog Shift Register, 185 stage	TCA350	ITT	
Balanced Modulator/Demodulator	μA796C	Fairchild	
	LS1496	Lithic Sys	
	LS1596	† Lithic Sys	
	MC1496	Motorola	
	MC1596	† Motorola	60
	MC12002	Motorola	
	MC12502	† Motorola	
	LM1496	National	
	(Cont'd)		

Function	Device	Source	Line
Other Linear Devices (Cont'd)			
Balanced Modulator/Demodulator (Continued)	LM1596	† National	
	AN610	Panasonic	
	SL640C	Plessey	
	SL641C	Plessey	70
	SL1001A	Plessey	
	SL1001B	Plessey	
	SL1496	Plessey	
	SL1596	† Plessey	
	SL1640	Plessey	
	LS1641	Plessey	
	S042	Siemans	
	MC1496	Signetics	
	MC1596	† Signetics	
	NE5596	Signetics	80
	SE5596	† Signetics	
	TCA240	Signetics	
	SG1496	Silicon G	
	SG1596	Silicon G	
Ring Modulator, four transistor	SL355	Plessey	
	TBA673	Signetics	
Blowout Resistant Transistor (simulates 40 v transistor with special protection)	LM195	† National	90
	LM295	National	
Bucket Brigade Device (Dual 64 stage, acts as a variable delay line in the audio range)	MN3003	Panasonic	
Bucket Brigade Device (Single/Dual 512 stage, acts as a variable delay line in the audio frequency range)	MN3001	Panasonic	
	MN3002	Panasonic	
Crystal Oscillators	SP705	Plessey	100
	SL680	Plessey	
Comparators, Programmable with Memory (High/Low Comparator)	CA3098	† RCA	
	CA3099	† RCA	
Comparator with latch (for SP750 A/D)	SP750B	Plessey	
Customized Arrays (Linear and Digital circuits, customized in final metalization)	XR-CHIP	Exar	110
	XR-IIL-CHIP	Exar	
	ULA	Ferranti	
	MONOCHIP	Interdesign	
	ECL-ARRAY	Plessey	
	TTL-ARRAY	Plessey	
	RTL-ARRAY	Plessey	
	SWAP	SW	
Data Acquisition System, 8 channel, sample/hold, 8-bit conversion	MN7100	Micro Net	120
DC to DC Converter	MCC138	Micro Comp	
	MCC139	Micro Comp	

Function	Device	Source	Line
Other Linear Devices (Cont'd)			
DC to DC Converter: See Regulators, Switching, this section			
Divider (See also Multipliers/Dividers below)	4291	Burr-Brown	
Dual Transistors, Monolithic, Matched, See Linear-Arrays			130
DVM Circuits-See Interface-Analog to Digital Converters, also Digital-Special			
Flasher (LED)	LP1000	Lithic Sys	
	LS3909	Lithic Sys	
	LM3909	National	
	LM3909	**Siliconix (604)**	
Fluid Detector (ocillator, balance detector)	LM1830	National	140
Frequency to Voltage (Pulse) Converter	SAK140	Signetics	
Frequency Switch, Programmable	MC3444	Motorola	
Frequency/Tone Operated Devices-See Linear-Telecommunication			
Frequency to Voltage Converter (tachometer-speed switch)	LM2907	National	
	LM2917	National	150
Frequency to Voltage/Voltage to Frequency Converter	A8400	Intech	
	A8400ET	† Intech	
	A8402	Intech	
	A8402ET	Intech	
	A8404	Intech	
Hall Effect Devices (Sense magnetic field) See also Digital-Other Digital Devices	DN835	Panasonic	160
	ULN-3006	Sprague	
	ULN-3008	Sprague	
Image Sensor, 256 x 1, CCD	CCD110	Fairchild	
Image Sensor, 500 x 1, CCD	CCD101	Fairchild	
Image Sensor, 1728 x 1, CCD	CCD121	Fairchild	
Image Sensor, Linear Self Scanning	IPL3010	IPI	170
	IPL3016	IPI	
	IPL3032	IPI	
	IPL4050	IPI	
	IPL4064	IPI	
	IPL4100	IPI	
	IPL4128	IPI	
	IPL4256	IPI	
	IPL7050	IPI	
	IPL7064	IPI	
	IPL7100	IPI	180
	IPL7128	IPI	
	IPL7256	IPI	
	M128	IPI	
	M256	IPI	
	(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

LINEAR—Other Devices (Cont'd)

Function	Device	Source	Line
Other Linear Devices (Cont'd)			
Image Sensor, Linear Self Scanning (Continued)			
	M512	IPI	
	M768	IPI	
	M1024	IPI	
	RL16	Reticon	
	RL64	Reticon	
	RL128	Reticon	
	RL256	Reticon	10
	RL512	Reticon	
	RL936	Reticon	
	RL1024	Reticon	
	RL1728	Reticon	
	RL1872	Reticon	
Image Area Sensor, Self Scanning			
	2D1	IPI	
	RA32X32	Reticon	
	RA50X50	Reticon	
	RA100X100	Reticon	20
Image Area Sensor, Circular, Self Scanning			
	RO64	Reticon	
Image Area Sensor, 100 x 100, CCD			
	CCD201	Fairchild	
	CCD202	Fairchild	
Image Area Sensor, 190 x 224, CCD			
	CCD211	Fairchild	
Impedance Converter (Gyrator)			
	AF120	National	
	TCA580	Signetics	30
LED, Constant Current			
	NSL4944	National	
Level Detector, Precision, (with internal reference Schmitt trigger action)			
	MCC127	Micro Comp	
	MCC401	Micro Comp	
	MCC402	Micro Comp	
	MCC450	Micro Comp	
	TL560C	TI	
Level Detector, Precision Dual			40
	MCC122	Micro Comp	
	MCC129	Micro Comp	
	MCC130	Micro Comp	
Light to Frequency Converter			
	IPL13	IPI	
Light Detector (with buffer amplifier)			
	IPL16	IPI	
	MCC401	Micro Comp	
	CA3062	RCA	
Light Activated Switch			50
	ZNP100	Ferranti	
	IPL15	IPI	
	IPL17	IPI	
	PS12	IPI	
	PS24	IPI	
	MCC401	Micro Comp	
	MCC402	Micro Comp	
	MCC450	Micro Comp	
	U102	Telefunken	

Function	Device	Source	Line
Other Linear Devices (Cont'd)			60
Low Battery Indicator, triggers on 3v (for use with 3 NiCd cells)			
	7201	Intersil	
Motor, Stepping Motor Driver			
	SAA1027	Signetics	
Motor Speed Regulator (for small dc motors)			
	μA7391	Fairchild	
	MCC140	Micro Comp	
	LM1815	National	
	SL440	Plessey	70
	TCA900	SGS	
	TCA910	SGS	
	TDA1003	Signetics	
Multipliers			
	XR2208	Exar	
	A8495	Intech	
	A8595	† Intech	
	8013C	Intersil	
	8013M	† Intersil	
	LS1495	Lithic Sys	80
	LS1595	† Lithic Sys	
	MC1494	Motorola	
	MC1594	† Motorola	
	MC1495	Motorola	
	MC1595	† Motorola	
	SL1495	Plessey	
	SL1595	† Plessey	
	CA3091	† RCA	
	SG1402	† Silicon G	
	SG2402	Silicon G	90
	SG3402	Silicon G	
	SG1495	Silicon G	
	SG1595	† Silicon G	
	TA7158	Toshiba	
Multipliers/Dividers			
	AD530	**AD**	**(576)**
	AD530S	**† AD**	**(576)**
	AD532	**AD**	**(576)**
	AD532S	**† AD**	**(576)**
	AD533	**AD**	**(577)** 100
	AD533S	**† AD**	**(577)**
	AD534J	**AD**	**(577)**
	AD534K	**AD**	**(577)**
	AD534S	**† AD**	**(577)**
	AD534T	**† AD**	**(577)**
	4201	Burr-Brown	
	4203	Burr-Brown	
	4203	Burr-Brown	
	4203	† Burr-Brown	
	4204	Burr-Brown	110
	4204S	† Burr-Brown	
	4205	Burr-Brown	
	4205S	† Burr-Brown	
	4206	Burr-Brown	
	4213	Burr-Brown	
	1401	† DDC	
Multifunction Convertors (XY/Z) <M>			
	AD531J	**AD**	**(576)**
	AD531K	**AD**	**(576)**
	AD531L	**AD**	**(576)** 120
	AD531S	**† AD**	**(576)**
	(Cont'd)		

Function	Device	Source	Line
Other Linear Devices (Cont'd)			
Multifunction Convertors (XY/Z) <M> (Continued)			
	4301	Burr-Brown	
	4302	Burr-Brown	
Noise Generator (psuedo-random sequence generator for audio)			
	MM5837	National	
Oscillator/Buffer			130
	4423	Burr-Brown	
	LM175	† National	
	LM275	National	
	LM375	National	
PIN Diode Switch Driver			
	DH0035	† National	
	DH0035C	National	
Power Supply Control (Oscillator with variable mark/space for switching supplies) See Regulators, Switching below			140
	SL442	Plessey	
Pressure Transducers			
	SH4207	Fairchild	
	LX1400	National	
	LX1600	National	
	LM1700	National	
	LX3700	National	
	LX3800	National	
Radio Transmitter			
	LP2000	Lithic Sys	150
	LP2001	Lithic Sys	
Radio Transmitter/Receiver			
	LP2700	Lithic Sys	
Read Amplifier/Preamplifier (for magnetic tape memories)			
	MC3467	Motorola	
	MC3468	Motorola	
Smoke Detector			
	MCC158	Micro Comp	
Voltage, Over-voltage Protector (Crowbar)			160
	MC3423	Motorola	
	MC3523	† Motorola	
Voltage Detector, Indicator, Regulator, (Programmable Zener)			
	8211C	Intersil	
	8211M	† Intersil	
	8212C	Intersil	
	8212M	† Intersil	
Voltage Reference Diode (two terminal active circuit) 1,220v ±5!			170
	MPS5010	Micro Power	
	LM113	† National	
	LM313	National	
Voltage Reference, 1.26v (two terminal active circuit)			
	ZN423	Ferranti	
Voltage Reference, 2.5v			
	AD580	**† AD**	**(579)**
Voltage Reference, 5v			
	REF-02	† PMI	180

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

LINEAR—Other Devices (Cont'd)

Other Linear Devices (Cont'd)

Function	Device	Source	Line
Voltage Reference Source, 6.9v temperature stabilized			
	LM129	† National	
	LM329	National	
	LM199	† National	
	LM299	National	
	LM399	National	
	LM199A	† National	
	LM299A	National	10
	LM399A	National	
	LM3999	National	
Voltage Reference Source, 10v			
	AD2700L	**AD (579)**	
	AD2700U	**† AD (579)**	
	AD2701L	**AD (579)**	
	AD2701U	**† AD (579)**	
	840-T1	Beckman	
	840-T2	Beckman	
	MN2000	Micro Net	20
	MN2001	Micro Net	
	MN2002	Micro Net	
	MN2003	Micro Net	
	LH0070	† National	
	REF-01	† PMI	
Voltage Reference Source, 10.24v			
	LH0071	Lithic Sys	
	LH0071	National	
Voltage Reference Source, ±10v			
	AD2702L	**AD (579)**	30
	AD2702U	**† AD (579)**	
	MN2004	Micro Net	
	MN2005	Micro Net	
Voltage Reference, Adjustable			
	TL430	TI	
Regulator Diode (two terminal active circuit) 1.8 to 5.6v			
	LM103	† National	
Regulators, Switching Regulator Circuits			
	ZN1066	Ferranti	40
	MC3380	Motorola	
	MC3420	Motorola	
	MC3520	† Motorola	
	TDA2640	Signetics	
	SL442	Plessey	
	SG1524	† Silicon G	
	SG2524	Silicon G	
	SG3524	Silicon G	
	TL497I	TI	
	TL497M	† TI	50
RMS to DC Converter			
	AD536J	**AD (577)**	
	AD536K	**AD (577)**	
	4340	Burr-Brown	
	4341	Burr-Brown	
Sample and Hold Circuits			
	AD582	AD	
	AD583	**AD (579)**	
	SHC23	Burr-Brown	
	SHC23ET	† Burr-Brown	60
	SHC80	Burr-Brown	
	(Cont'd)		

Function	Device	Source	Line
Sample and Hold Circuits (Continued)			
	SHC85	Burr-Brown	
	SHC85ET	Burr-Brown	
	SHM-IC-1	Datel	
	SHM-HZ	Datel	
	SHM-LM-2	Datel	
	1502	DDC	
	HA-2420	**Harris (581)**	70
	HA-2425	**† Harris (580)**	
	SH702	Hybrid Sys	
	IH5110	† Intersil	
	IH5111	† Intersil	
	MN343	† Micro Net	
	LH0023	† National	
	LH0023C	National	
	LH0043	† National	
	LH0043C	National	
	LH0053	† National	80
	LH0053C	National	
	SHM6401	National	
	LF198	† National	
	LF298	National	
	LF398	National	
	CSH101A	† Teledyne C	
	4856	Teledyne P	
SCR/TRIAC Control (Burst Control)			
	L121	SGS	
SCR/TRIAC Control (Phase Control)			90
	SL440	Plessey	
	L120	SGS	
Serial Analog Delay (Analog storage units with read in/read out shift register) (See also Bucket Brigade above)			
	SAD100	Reticon	
	SAD512	Reticon	
	SAD1024	Reticon	
Analog Delay, Tapped (Bucket Brigade with 32 taps)			100
	TAD32	Reticon	
Serial Analog Memory (Analog storage with independent read-in and read-out shift registers)			
	SAM64	Reticon	
	SAM128	Reticon	
Analog Random Access Memory			
	ARAM64	Reticon	
Servo Amplifier, for motor control			
	NE543	Signetics	110
	NE544	Signetics	
Sinewave Generator			
	FX205	CMA	
Sonar Transceiver			
	LM1812	National	
Square Law Device (two quadrant)			
	SL645	Plessey	
Tachometer: See Frequency to Voltage and Frequency Switch above			
Thermal Converter (matched transistors, diffused resistors)			120
	4131	Burr-Brown	

Function	Device	Source	Line
Temperature Controlled Differential Pair			
	ITT726-1	† ITT	
	ITT726-5	ITT	
	μA726C	Fairchild	
	μA726M	† Fairchild	
Temperature Transducers			
	REF-02	† PMI	
	LM3911	National	130
	LX5600	† National	
	LX5700	† National	
Threshold Switch (2/3 supply voltage)			
	MCC102	Micro Comp	
	MCC560	Micro Comp	
	MCC550	Micro Comp	
	TCA345	Siemens	
Timers: See Linear-Timers			
Dual Voltage Level Alarm (activated if either input differs by more than ±5 to ±25! of selected value)			140
	3041	Intech	
Quad Voltage Level Monitor/Alarm (avtivated if any of 4 inputs differs by more than ±5, ±10 or ±20! of selected value)			
	3040	Intech	
Voltage to Frequency Converter			
	AD537	AD	
	VFC32	Burr-Brown	
	XR4151	Exar	150
	RC4151	**Raytheon (590)**	
	RM4151	**† Raytheon (590)**	
	RV4151	**Raytheon (590)**	
	9400	Teledyne S	
Voltage to Frequency/Frequency to Voltage Converter			
	A8400	Intech	
	A8400ET	† Intech	
	A8402	† Intech	
Zero Voltage and Zero Crossing Triggers (Triac and SCR control)			160
	XR742	Exar	
	μA742C	Fairchild	
	MC3359	Motorola	
	MC3370	Motorola	
	SL447	Plessey	
	SL448	Plessey	
	SL449	† Plessey	
	CA3058	† RCA	
	CA3059	† RCA	170
	CA3079	† RCA	
	TCA280	Signetics	
	SG3058	† Silicon G	
	SG3059	Silicon G	
	SG3079	Silicon G	
	U106	Telefunken	
	U112	Telefunken	
	TL440C	TI	

† Military Temperature Range (−55°C to 125°C)

FET INPUT IC OP AMPS

Analog Devices provides the broadest range of IC FET-INPUT OP AMPS in the industry. For use in applications where low bias current and high input impedance are imperative, FET-input amplifiers are available in versions where low offset voltage, speed, low noise, ultra-low bias current or low cost are also design considerations. The newest addition to the Analog Devices FET-input op amp line is the AD515. With bias current as low as 75fA and offset voltage below 1.0mV, the AD515 represents the ultimate in FET amplifier design.

SPECIFICATIONS (min, max @ V_S = ±15V, T_A = +25°C unless otherwise noted)

Model	††Temp Range	I_b pA	V_{OS} mV	$\Delta V_{OS}/\Delta T$ µV/°C	V_{DIFF} @ Rated I_B ±V	Gain	V_{OUT} ±V @ mA	CMRR dB	Frequency Response Unity Gain MHz	Frequency Response Slew Rate V/µsec	†Package	Price (100's) ($)
AD503J	C	15	50	75	4.0(T)	20k	10/5	70	1.0(T)	3.0	H	11.40
AD503K	C	10	20	25	4.0(T)	50k	10/5	80	1.0(T)	3.0	H	16.00
AD503S	M	10	20	50	4.0(T)	50k	10/5	80	1.0(T)	3.0	H	20.00
AD506J	C	15	3.5	75	44.0(T)	20k	10/5	70	1.0(T)	3.0	H	9.50
AD506K	C	10	1.5	25	4.0(T)	50k	10/5	80	1.0(T)	3.0	H	11.00
AD506L	C	5	1.0	10	4.0(T)	75k	10/5	80	1.0(T)	3.0	H	16.00
AD506S	M	10	1.5	50	4.0(T)	50k	10/5	80	1.0(T)	3.0	H	17.60
AD515J	C	.300	3.0	50	20	40k	10/5	66	.35(T)	0.3	H	9.90
AD515K	C	.150	1.0	15	20	100k	10/5	80	.35(T)	0.3	H	14.00
AD515L	C	.075	1.0	25	20	50k	10/5	70	.35(T)	0.3	H	18.00
AD514J	C	50	50	75	20	20k	10/5	70	.75	0.5	H	5.90
AD514K	C	20	20	25	20	50k	10/5	70	.75	0.5	H	7.90
AD514L	C	10	20	25	20	50k	10/5	70	.75	0.5	H	9.90
AD514S	M	20	20	50	20	50k	10/5	70	.75	0.5	H	11.90
AD523J	C	1.0	50	90	4.0(T)	20k	10/5	70	0.5(T)	3.0	H	14.00
AD523K	C	0.5	20	30	4.0(T)	40k	10/5	80	0.5(T)	3.0	H	16.75
AD523L	C	0.25	20	60	4.0(T)	40k	10/5	80	0.5(T)	3.0	H	18.75
AD528J	C	30	3	50	20(T)	25k	10/5	70	10(T)	50	H	12.00
AD528K	C	15	1	25	20(T)	50k	10/5	80	10(T)	50	H	16.00
AD528S	M	15	1	25	20(T)	50k	10/5	80	10(T)	50	H	28.00
AD540J	C	50	50	75	20(T)	20k	10/5	70	1.0(T)	6.0(T)	H	4.45
AD540K	C	25	20	25	20(T)	50k	10/5	70	1.0(T)	6.0(T)	H	5.95
AD540S	M	25	20	50	20(T)	50k	10/5	70	1.0(T)	6.0(T)	H	9.95

(T) = Typical

FAST WIDEBAND IC OP AMPS

High Speed Op Amps are those characterized by wide bandwidth (>4MHz), high slew rate (>20V/microsecond) and low settling time. The devices listed below offer the user a variety of AC specifications for any applications including 8, 10 and 12-bit converters.

SPECIFICATIONS (min, max @ V_S = ±15V, T_A = +25°C unless otherwise noted)

Model	††Temp Range	Gain	V_{OUT} ±V @ mA	Unity Gain MHz	Slew Rate V/µsec	Settling Time µsec to 0.1%	V_{OS} mV	$\Delta V_{OS}/\Delta T$ µV/°C	I_b nA	I_{OS} nA	CMRR dB	†Package	Price (100's) ($)
AD507J	C	80k	10/5	35(T)	20	0.9(T)	5.0	15(T)	25	25	25	H	6.95
AD507K	C	100k	10/5	35(T)	25	0.9(T)	3.0	15	15	15	80	H	10.00
AD507S	M	100k	10/5	35(T)	20	0.9(T)	4.0	20	15	15	80	H	15.00
AD509J	C	7.5k	10/5	20	80	0.2(T)	10.0	20	250	50	74	H	8.95
AD509K	C	10k	10/5	20	80	0.5(T)	8.0	30	200	25	80	H	12.50
AD509S	M	10k	10/5	20	100	0.5(T)	8.0	30	200	25	80	H	19.75
AD518J	C	25k	10/5	12	50	0.8(T)	10.0	10	500	200	70	H	1.95
AD518K	C	50k	10/5	12	50	0.8(T)	4.0	15	250	50	80	H	4.95
AD518S	M	50k	10/5	12	50	0.8(T)	4.0	20	250	50	80	H	11.95

(T) = Typical

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Route 1 Industrial Park; P.O. Box 280; Norwood, Mass. 02062
Tel: 617/329-4700 **TWX: 710/394-6577**
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HIGH ACCURACY IC OP AMPS

Where low offset voltage, low drift, low noise and long term stability are paramount, Analog Devices provides a line of high accuracy op amps at extremely low costs. As well as high performance versions of the popular 741 and 301 type amplifiers, ADS offers high accuracy devices with offset voltage laser-trimmed to 25μV max, drift below 25μV/°C and voltage noise of 1μV p-p, such as the new AD510.

SPECIFICATIONS (min, max @ V_S = ±15V, T_A = +25°C unless otherwise noted)

Model	††Temp Range	Gain	V_{OUT} ±V @ mA	V_{OS} mV	$\Delta V_{OS}/\Delta T$ μV/°C	I_b nA	I_{OS} nA	CMRR dB	Noise μV p-p (0.01 to 10Hz)	Frequency Response Unity Gain MHz	Slew Rate V/μsec	†Package	Price (100's) ($)
AD301AL	C	80k	10/5	0.5	5.0	30	5.0	90	3.0(T)	1.0 to 8.0(T)*	0.5 to 10(T)*	H,N	6.00
AD504J	C	250k	10/5	2.5	5.0	200	40	94	1.0(T)	0.3 to 1.0(T)*	0.12 to 2.5(T)*	H	8.40
AD504K	C	500k	10/5	1.5	3.0	100	15	100	1.0(T)	0.3 to 1.0(T)*	0.12 to 2.5(T)*	H	15.30
AD504L	C	1000k	10/5	0.5	1.0	80	10	110	1.0(T)	0.3 to 1.0(T)*	0.12 to 2.5(T)*	H	20.40
AD504M	C	1000k	10/5	0.5	0.5	80	10	110	0.6**	0.3 to 1.0(T)*	0.12 to 2.5(T)*	H	22.00
AD504S	M	1000k	10/5	0.5	1.0	80	10	110	1.0(T)	0.3 to 1.0(T)	0.12(T)	H	24.00
AD508J	C	250k	10/5	2.5	3.0	25	5.0	94	1.0(T)	0.3 to 1.0(T)*	0.12 to 2.5(T)*	H	14.00
AD510J	C	250k	10/5	.100	3.0	25	5	94	1.0(T)	0.3(T)	0.10(T)	H	5.95
AD510K	C	1000k	10/5	.050	1.0	13	4	110	1.0(T)	0.3(T)	0.10(T)	H	9.95
AD510L	C	1000k	10/5	.025	0.5	10	2.5	110	1.0(T)	0.3(T)	0.10(T)	H	14.95
AD510S		1000k	10/5	.050	1.0	13	4	110	1.0(T)	0.3(T)	0.10(T)	H	24.50
AD741J	C	50k	10/10	3.0	20	200	50	80	3.0(T)	1.0(T)	0.5(T)	H,N	1.25
AD741K	C	50k	10/5	2.0	15	75	10	90	3.0(T)	1.0(T)	0.5(T)	H,N	2.25
AD741L	C	50k	10/5	0.5	5.0	50	5	90	3.0(T)	1.0(T)	0.5(T)	H,N	6.00
AD741S	M	50k	10/10	2.0	15	75	10	80	3.0(T)	1.0(T)	0.5(T)	H	3.30

*Parameter range with various external compensation schemes. (T) = Typical
**100% tested and guaranteed from 0.1 to 10Hz.

GENERAL PURPOSE IC OP AMPS

Where only moderate performance is required, a good *General Purpose Op Amp* is the best price/performance choice. Analog Devices provides the popular 741, 301 and 308 type devices with performance and reliability a cut above the standard general purpose op amp.

SPECIFICATIONS (min, max @ V_S = ±15V, T_A = +25°C unless otherwise noted)

Model	††Temp Range	Gain	V_{OUT} ±V @ mA	Frequency Response Unity Gain MHz	Slew Rate V/μsec	V_{OS} mV	$\Delta V_{OS}/\Delta T$ μV/°C	I_b nA	I_{OS} nA	CMRR dB	Noise μV p-p (0.01 to 10Hz)	†Package	Price (100's) ($)
AD101A	M	50k	10/5	1.0 to 8.0(T)	0.5 to 10(T)	2.0	15	75	10	80	3.0(T)	H	2.25
AD201A	I	50k	10/5	1.0 to 8.0(T)	0.5 to 10(T)	2.0	15	75	10	80	3.0(T)	H,N	1.75
AD301A	I	25k	10/5	1.0 to 8.0(T)	0.5 to 10(T)	7.5	30	250	50	70	3.0(T)	H,N	1.00
AD108	M	50k	13/1.3	0.3 to 3.0(T)	0.3 to 1.3(T)	2.0	15	2.0	0.2	85	2.0(T)	H	12.50
AD208	I	50k	13/1.3	0.3 to 3.0(T)	0.3 to 1.3(T)	2.0	15	2.0	0.2	85	2.0(T)	H	4.75
AD308	I	25k	13/1.3	0.3 to 3.0(T)	0.3 to 1.3(T)	7.5	30	7.0	1.0	80	2.0(T)	H	3.50
AD108A	M	80k	13/1.3	0.3 to 3.0(T)	0.3 to 1.3(T)	0.5	5.0	2.0	0.2	96	2.0(T)	H	17.50
AD208A	I	80k	13/1.3	0.3 to 3.0(T)	0.3 to 1.3(T)	0.5	5.0	2.0	0.2	96	2.0(T)	H	14.00
AD308A	I	80k	13/1.3	0.3 to 3.0(T)	0.3 to 1.3(T)	0.5	5.0	7.0	1.0	96	2.0(T)	H	7.00
AD502J	I	20k	10/5	1.0(T)	0.5(T)	6.0	40	25	12	80	15(T)	H	3.85
AD502K	I	20k	10/5	1.0(T)	0.5(T)	5.0	20	7	4	80	15(T)	H	7.75
AD502L	I	20k	10/5	1.0(T)	0.5(T)	5.0	10	4	1	80	15(T)	H	16.15
AD502S	M	20k	10/5	1.0(T)	0.5(T)	5.0	20	10	5	80	15(T)	H	12.85
AD741	M	50k	10/5	1.0(T)	0.5(T)	5.0	-	500	200	70	3.0(T)	H,N	2.00
AD741C	I	20k	10/5	1.0(T)	0.5(T)	6.0	-	500	200	70	3.0(T)	H,N	1.00

†Package Designation: H – TO-99 can
N – 8 pin mini DIP

††Temperature: C = 0 to +70°C
I = -25°C to +85°C
M = -55°C to +125°C

(T) = Typical

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Analog Devices is the industry's leading supplier of Analog Functional Circuits. Utilizing the patented Gilbert Linearized Transconductance Technique, ADI has developed a line of low cost, monolithic circuits with multiplying, dividing, squaring and square rooting functions. The most recent development is the AD536, the world's first monolithic RMS to DC converter.

The Analog Devices AD530 is the industry's first integrated circuit multiplier to include the transconductance multiplying element, stable reference, and output amplifier on a monolithic silicon chip. The AD530 multiplies in four quadrants with a transfer function of XY/10, divides in two quadrants with 10Z/X transfer function, and square roots in one quadrant with a transfer function of $-\sqrt{10Z}$.

The AD531 is the first monolithic programmable multiplier/divider to provide the true transfer function $V_X \cdot V_Y/kI_Z$ without the need for an external level shifting op amp at the output. Not just a multiplier, the AD531 is truly a computation circuit that is ideally suited to such applications as automatic gain control (AGC), true RMS-to-DC conversion, ratio determination and vector operations; in addition, it provides the normal mathematical functions of four-quadrant multiplication, two-quadrant division, squaring, and square rooting. Flexibility of operation is achieved by means of the variable scale factor kI_Z, which can be set by an external resistor or varied dynamically by an externally derived reference current to obtain the overall transfer function $V_X \cdot V_Y/V_Z$.

The AD532 is the first pretrimmed single chip monolithic multiplier/divider. It guarantees a maximum multiplying error of ±1.0% and a ±10V output voltage without the need for any external trimming resistors or output op amp. Because the AD532 is internally trimmed, its simplicity of use provides

SPECIFICATIONS (min, max @ V_S = ±15V, T_A = +25°C unless otherwise noted)

Models	530J (530K) (530L) (530S)	531J (531K) (531L) (531S)	532J (532K) (532S)
Full Scale Accuracy	2% (1%) (0.5%) (1%)	2% (1%) (0.5%) (1%)	2% (1%) (1%)
Divides and Square Roots	YES	YES	YES
Multiplication Characteristics			
Output Function	XY/10	XY/I_{REF}	$(X_1 - X_2)(Y_1 - Y_2)/10$
Accuracy vs. Temperature (±)	0.06(0.03)(0.01)(0.02 max)%/°C	0.06(0.03)(0.01)(0.02 max)%/°C	0.06(0.03)(0.02)%/°C
Accuracy vs. Supply (±)	0.2%/%	0.2%/%	0.2%/%
Output Offset (±)			
Initial	Adj. to zero	Adj. to zero	±50mV max(±20mV max)(±20mV max)
Average vs. Temperature 0 to +70°C	0.2mV/°C	0.2mV/°C	0.7(0.7)(2.0 max)mV/°C
Scale Factor (±)	Fixed	Dynamically Variable	Fixed
Initial Error	Adj. to 1%(0.5%)(0.2%)(0.5%)	Adj. to 1%(0.5%)(0.2%)(0.5%)	Adj. to 1%(0.5%)(0.5%)
Nonlinearity (±)			
X Input (X = 20V p-p, Y = ±10VDC)	0.8%(0.5%)(0.3%)(0.5%)	0.8%(0.5%)(0.3%)(0.5%)[1]	0.8%(0.5%)(0.5%)
Y Input (Y = 20V p-p, X = ±10VDC)	0.3%(0.2%)(0.2%)(0.2%)	0.3%(0.2%)(0.2%)(0.2%)[1]	0.3%(0.2%)(0.2%)
Feedthrough			
X = 0, Y = 20V p-p 50Hz	—	—	150mV(100mV)(100mV)p-p max
with external trim	100mV(60mV)(30mV)(60mV)p-p max	150mV(80mV)(40mV)(80mV)p-p max[1]	—
Y = 0, X = 20V p-p 50Hz	—	—	200mV(100mV)(100mV)p-p max
with external trim	150mV(80mV)(40mV)(80mV)p-p max	100mV(60mV)(30mV)(60mV)p-p max[1]	—
Bandwidth			
-3dB Small Signal	1MHz	1MHz	1MHz
Full Power Response	750kHz	750kHz	750kHz
Slew Rate	45V/μsec	45V/μsec	45V/μsec
Output Characteristics			
Voltage at Rated Load (min)	±10V	±10V	±10V
Current (min)	±5mA	±5mA	±5mA
Input Resistance			
X/Y/Z Input[2]	10MΩ/6MΩ/36kΩ	10MΩ/6MΩ/36kΩ	10MΩ/10MΩ/36kΩ
Input Bias Current			
X/Y/Z Input	2μA/2μA/5μA	2μA/2μA/5μA	2μA/3μA/5μA
Power Supply (V_S)			
Rated Performance	±15V	±15V	±15V
Operating	±12 to ±18V	±12 to ±18V	±10 to ±18V
Quiescent Current	±4mA	±4.5mA	±4mA
Price (100's)	$15.00($22.50)($27.50)($34.00)	$8.90($13.35)($30.25)($35.85)	$16.00($24.50)($32.50)

[1] I_{REF} = full scale. *Call factory for pricing.

[2] Z input current is proportional to Z input voltage.

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design engineers with an attractive alternative to modular multipliers, and its monolithic construction provides significant advantages in size, reliability and economy. Further, the AD532 can be used as a direct replacement for other IC multipliers that require external trim networks (such as the AD530).

The Analog Devices AD533 is a low cost integrated circuit multiplier comprised of a transconductance multiplying element, stable reference, and output amplifier on a monolithic silicon chip. Specified accuracy is easily achieved by the straightforward adjustment of feedthrough, output zero, and gain trim pots. The AD533 multiplies in four quadrants with a transfer function of XY/10, divides in two quadrants with a 10Z/X transfer function, and square roots in one quadrant with a transfer function of $-\sqrt{10Z}$.

The AD534 is the most accurate IC multiplier/divider manufactured today. Laser trimming provides accuracies up to 0.25% max error at +25°C (AD534L) and 1.0% max error from -55°C to +125°C (AD534T).

The first monolithic RMS to DC converter, the AD536 provides the true RMS value of any complex waveform without the need for external adjustment. The device utilizes a crest factor compensation scheme to achieve less than 1% error at a crest factor of 7.

533J (533K) (533L) (533S)	534J (534K) (534L) (534S) (534T)
2% (1%) (0.5%) (1%)	1% (0.5%) (0.25%) (1%) (0.5%)
YES	YES
XY/10	$(X_1 - X_2)(Y_1 - Y_2)/10$
0.04(0.03)(0.01)(0.01)%/°C	0.02(0.01)(0.005)(0.02)(0.005)%/°C
0.5%/%	0.01%/%
Adj. to zero	±30(10)(15)(30)(10)mV
0.7mV/°C	0.2(0.1)(0.1)(0.5)(0.3)mV/°C
Fixed	3 to 13
Adj. to 1%	Adj. to ±0.25(0.1)(0.1)(0.25)(0.1)%
0.8%(0.5%)(0.5%)(0.5%)	0.4%(0.3%)(0.12%)(0.4%)(0.3%)
0.3%(0.2%)(0.2%)(0.5%)	0.1%
—	—
150mV(100mV)(50mV)(100mV)p-p max	3mV(3mV)(1.2mV)(3mV)(3mV)p-p max
—	—
200mV(100mV)(50mV)(100mV)p-p max	1mVp-p max
1MHz	1MHz
750kHz	750kHz
45V/μsec	20V/μsec
±10V	±10V
±5mA	±5mA
10MΩ/6MΩ/36kΩ	10MΩ
3μA(7.5μA max)(5μA max)(7.5μA max)	2μA
±15V	±15V
±12 to ±18V	±6 to ±18V
±4mA	±6mA
$5.95($9.95)($25.00)($30.00)	

SPECIFICATIONS

(typical @ +25°C and ±15VDC unless otherwise noted)

Models	536J (536K)
Transfer Equation	$V_{OUT} = \sqrt{\text{avg. } (V_{IN})^2}$
Conversion Accuracy	
Total Error	
Input: 0 to $7V_{RMS}$	±5mV ±0.5% (±2mV ±0.2%) of Rdg., max
vs. Temperature (0 to +70°C)	±(0.1mV ±0.02%)(0.1mV ±0.01%)/°C
vs. Supply Voltage	±0.01%/V (±0.01%/V max)
Crest Factor	
Rated Accuracy	4
±1% Reading Error	6
-3% of Reading Error	10
Frequency Response (Sinewave)	
Rated Accuracy	
Input: 0.1 to $7V_{RMS}$	20kHz
±1% Reading Error	
Input: 0.1 to $7V_{RMS}$	100kHz
Bandwidth, -3dB, $1V_{RMS}$	1MHz
External Filter Time Constant	25ms/μF
Signal Output	
Rated Output, Pin 6	
Voltage, ±15V Supplies	0 to +10V min
Voltage, 0, +5V Supplies	0 to +2V min
Current	5mA min
Resistance	0.5Ω max
Short Circuit Current	20mA
Offset Voltage	±2mV max (±1mV max)
vs. Temperature (0 to +70°C)	±100μV/°C
vs. Supply	±100μV/V
Signal Input, Pin 1	
Signal Range ±15V Supply	±20V Peak
Signal Range 0, +5V Supply	±4V Peak (AC - coupled)
Safe Input ±15V Supply	±30V
Input Impedance	16.7kΩ ±20%
dB Output	
Scale Factor (+25°C)	-3mV/dB
I_{REF}, $1.0V_{RMS}$ = 0dB	15μA ±5μA
Accuracy ($1.0V_{RMS}$ = 0dB)	
Input: 7mV to $7V_{RMS}$	±0.5(±0.2)dB
vs. Temperature (0 to +70°C) (Uncompensated)	-0.3%/°C – 0.03dB/°C
Power Supply	
Voltage Rated Performance	
Dual Supply	±2.5 to ±18V
Single Supply	+5 to +36V
Quiescent Current	1mA
Peak Current	4mA + Output Current
Temperature Range	
Operating	0 to +70°C
Storage	-55°C to +150°C
Price (100's)	*

*Call factory for pricing.

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IC Instrumentation Amplifiers

AD520, AD521, AD522

An *Instrumentation Amplifier* is a controlled gain block with differential inputs and an accurately programmable input/output gain relationship. Its excellent common mode rejection and low gain error make it a natural choice for extracting and amplifying low level signals in the presence of high common mode noise voltages. Instrumentation amplifiers are commonly used as transducer amplifiers for thermo couples, strain gauge bridges, current shunts, biological amplifiers, or simply as preamplifiers for processing small differential signals superimposed on common mode voltages.

Instrumentation amplifiers should not be confused with op amps even through Analog Devices offers op amps that can be used as building blocks in variable gain instrumentation amplifier circuits. An op amp is merely a high gain component requiring the addition of external feedback to complete the amplification function. Because of the limitations of resistor matching in the external feedback circuit and the relatively low input impedance resulting from the input resistors, an instrumentation amplifier circuit designed around op amps frequently provides less than satisfactory performance. IC instrumentation amplifiers manufactured by ADI, the AD520, AD521, and AD522 are complete amplification circuits which do not depend upon external resistor matching for input/output isolation, they maintain their high CMRR in any application.

The AD520 and AD521 were the first instrumentation amplifiers to be manufactured in integrated circuit form. They offer the benefits of a true instrumentation amplifier at a cost and ease of use that previously made them prohibitive.

The AD522 is a precision IC instrumentation amplifier designed for applications requiring high accuracy under worst-case operating conditions. An outstanding combination of high linearity, high common mode rejection, low voltage drift, and low noise makes the AD522 suitable for use in many 12-bit data acquisition systems.

SPECIFICATIONS (min, max @ V_S = ±15V, T_A = +25°C unless otherwise noted)

	AD520J(K)(S)	AD521J(K)(S)	AD522A(B)(C)(S)
GAIN			
Range	1 to 1000	1 to 1000	1 to 1000
Equation	$G = R_S/R_G$ V/V	$G = R_S/R_G$V/V	$1 + 2 \times 10^5 R_G$
Nonlinearity	±0.5% max	±0.2% max	±0.005(0.001)(0.001)(0.001)% max
OUTPUT	±10V @ 5mA min	±10V @ 5mA min	±10V @ 5mA min
BANDWIDTH (±3dB)			
G = 1	200kHz	2MHz	300kHz
G = 1000	25kHz	40kHz	300Hz
SLEW RATE	2.5V/μs	10V/μs	0.1V/μs
VOLTAGE OFFSET, Output	Must Be Nulled	±400 + 3 x G (200 + 1.5G) (200 + 1.5G)mV max	±200(100)(100)(200)μV max
DRIFT, Output @ G = 1	±1(0.5)(0.5)mV/°C max	±0.415(0.205)(0.205)mV/°C max	±50(25)(10)(100)μV/°C max
INPUT BIAS CURRENT	80(40)(40)nA max	80(40)(40)nA max	25(15)(10)(25)nA max
INPUT OFFSET CURRENT	±40(20)(20)nA max	±20(10)(10)nA max	±20(10)(5)(20)nA max
INPUT IMPEDANCE			
Differential	$2 \times 10^9 \Omega$	$3 \times 10^9 \Omega$	$10^9 \Omega$
Common Mode	$2 \times 10^9 \Omega$	$6 \times 10^{10} \Omega$	$10^9 \Omega$
CMRR			
G = 1	65(70)(70)dB min	70(74)(74)dB min	75(80)(80)(75)dB min
G = 100	95(106)(106)dB min	100(110)(110)dB min	100dB min
TEMP. RANGE[1]	C(C)(M)	C(C)(M)	I(I)(I)(M)
PRICE (100's)	$12.00($16.00)($22.00)	$8.50($12.00)($20.00)	$13.00($16.00)($20.00)($30.00)

[1] C = 0 to +70°C, I = -25°C to +85°C, M = -55°C to +125°C

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Route 1 Industrial Park; P.O. Box 280; Norwood, Mass. 02062
Tel: 617/329-4700 TWX: 710/394-6577
West Coast 213/595-1783 Mid-West 312/894-3300 Texas 214/231-5094

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IC SAMPLE-HOLD

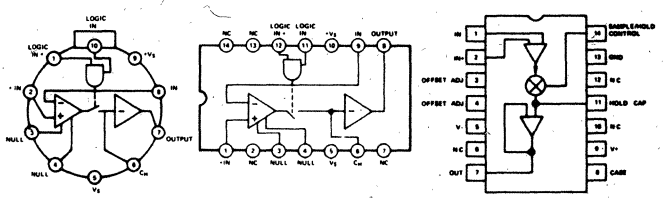
The AD582 and 583 are monolithic sample and hold circuits, each consisting of a high performance operational amplifier in series with an ultra-low leakage analog switch and a MOSFET input unity gain amplifier. An external holding capacitor, connected to the switch output, completes the sample-and-hold or track-and-hold function.

With the analog switch closed, the devices function like a standard op amp; any feedback network may be connected around the device to control gain and frequency response. With the switch open, the capacitor holds the output at its previous level. The AD582 and AD583 may be used as a versatile operational amplifier with a gated output for applications such as analog switches, peak holding circuits, etc.

The AD582 is the lowest cost sample-and-hold circuit available today and provides the performance to replace many modules. Where lower aperture time and greater accuracy are desired, the AD583 is recommended.

	AD582K	AD582S	AD583K
Open Loop Gain R_L = 2kΩ	25k min	25k min	25k min
Output Swing	±10V min	±10V min	±10V min
Gain Bandwidth	1.5MHz	1.5MHz	2MHz
Acquisition Time (0.1%) A_V = 1, R_L = 2k, C_L = 50pF	5μsec	5μsec	4μsec
Aperture Time	150nsec	150nsec	50nsec
Drift Current	50pA max	50pA max	50pA max
Charge Transfer	5pC max	5pC max	20pC max
Operating Temp.	C	M	I
Price (100's)	$5.95	$14.95	$14.85

TO-100 TO-116 TO-116



AD582H AD582D AD583

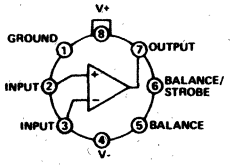
IC COMPARATORS

The AD111, AD211, and AD311 are precision voltage comparators designed for low level signal detection and high level output drive capability. Offering significant improvement over the earlier 710-type comparator in terms of bias currents and gain, the AD111 series operates on supply voltages from +5V (single ended) up to ±18V. TTL strobe capability is available with the addition of two external components. The AD311 is specified from 0 to +70°C, the AD211 from -25°C to +85°C and the AD111 over the full military temperature range -55°C to +125°C. All versions are available in the TO-99 can; the AD311 is also available in the 8 pin mini dip.

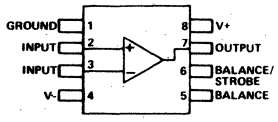
	AD311	AD211	AD111
Voltage Gain	200k	200k	200k
Offset Voltage (mV max)	7.5	3.0	3.0
Bias Current (nA max)	250	100	100
Maximum Output to $-V_S$	50V	50V	50V
Maximum Ground to $-V_S$	30V	30V	30V
Power Supply	+5V min*	+5V min*	+5V min*
Response Time, to TTL Logic Threshold (nsec)	200	200	200
Temp. Range	C	I	M
Price (100's)	$2.00	$7.50	$15.00

*Single Ended

TO-99 Top View



MINI-DIP Top View



IC REFERENCES

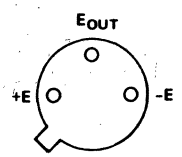
Two IC voltage references are available from Analog Devices. The AD580 is a low cost, three-terminal bandgap voltage reference which provides a fixed 2.5V output voltage for inputs between 4.5V and 30V. The AD2700/2701/2702 are medium cost, high accuracy references with +10.000V, -10.000V and ±10.000V outputs, respectively.

MODEL	OUTPUT VOLTAGE	*ERROR, mV MAX T_{min}, T_{max}	TEMP RANGE††	PRICE (in 100's)
AD580J	2.500 ±3%	+90	C	$ 2.00
AD580K	2.500 ±2%	+57	C	$ 4.00
AD580L	2.500 ±2%	+54.3	C	$ 5.75
AD580M	2.500 ±1%	+26.75	C	$ 8.25
AD580S	2.500 ±3%	+100	M	$ 7.50
AD580T	2.500 ±2%	+61	M	$12.00
AD580U	2.500 ±1%	+29.5	M	$25.00
AD2700L/U	10.000 ±0.01%	+3, -5	I/M	$10.00/14.00
AD2701L/U	-10.000 ±0.01%	+3, -5	I/M	$10.00/14.00
AD2702L/U	±10.000 ±0.01%	+3, -5	I/M	$12.00/16.00

*Including initial offset.

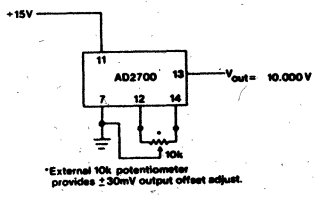
††C = 0 to +70°C, I = -25°C to +85°C, M = -55°C to +125°C

AD580 TO-47 PACKAGE



BOTTOM VIEW PIN OUT

AD2700 14-PIN DIP



PIN OUT

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HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HARRIS OPERATIONAL AMPLIFIERS

Selection Guide for Commercial/Industrial Applications

PARAMETER†	0°C to +75°C											UNITS
	HA-911	PRAM™ HA-2405	S/H HA-2425	HA-2505	HA-2515	HA-2525	HA-2535	HA-2605	HA-2625	HA-2635	HA-2645	
INPUT CHARACTERISTICS												
Offset Voltage	7.5	11	8	10	14	14	5	7	7	300	7	mV
Drift (Typ.)	15	30	5	20	30	20	5	5	5	(2)	15	μV/°C
Bias Current	750	500	400	500	500	500	200	40	40	200	50	nA
Offset Current	450	100	100	100	100	100	20	40	40	(2)	50	nA
Common Mode Range	±12	±10	±10	±10	±10	±10	±.5	±11	±11	(2)	±35 (4)	V
INPUT NOISE (3)	1											μVRMS
TRANSFER CHARACTERISTICS												
Large Signal Voltage Gain	15K	25K	25K	10K	5K	5K	100K	70K	70K	.85	75K	V/V
Common Mode Rejection Ratio	74	74	74	74	74	74	80	74	74	(2)	74	dB
Bandwidth (Typ.)	7	18 (3)	2 (3)	12 (3)	12 (3)	25	20	12	35	8	4	MHz
OUTPUT CHARACTERISTICS												
Output Voltage Swing	±11	±10	±10	±10	±10	±10	±10	±10	±10	±10	±35 (4)	V
Output Current (1)	±15	20 (3)	±10	±10	±10	±10	±25	±10	±10	±300	±10	mA
Full Power Bandwidth (Typ.) (1)	35	200 (3)	70 (3)	500	1,000	1,500	5,000	75	600	8,000	23	kHz
TRANSIENT RESPONSE												
Rise Time (1)	75	20	100 (3)	50	50	50	40	60	45	30 (3)	60 (3)	ns
Overshoot (1)	40	25	20 (3)	50	50	50	50	40	(2)	25 (3)	15 (3)	%
Slew Rate (1)	±2.3	15	5 (3)	±20	±40	±80	±250	±4	±20	200	5 (3)	V/μs
Settling Time (Typ.) (1)	(2)	1.5		0.33	0.25	0.20	.5	1.5	0.30	.5 (3)	1.5 (3)	μs
POWER SUPPLY CHARACTERISTICS												
Supply Current (1)	2.5	6.0	5.0	6.0	6.0	6.0	6.0	4.0	4.0	23	4.5	mA
Power Supply Rejection Ratio	74	74	74	74	74	74	80	74	74	66	74	dB
FUNCTIONAL CHARACTERISTICS												
Offset Adjust	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	
Compensation Components	0	OAV >10	0	0	0	OAV>3	1	0	OAV≥5	0	0	
Output Protection	No	No	Yes	No	No	No	No	Yes	Yes	External	Yes	

PARAMETER†	0°C to +75°C							-25°C to +85°C			UNITS
	HA-2655	HA-2705	HA-2725	HA-2735	HA-2905	HA-4741	HA-4605	PRAM™ HA-2404	HA-2704	HA-2904	
INPUT CHARACTERISTICS											
Offset Voltage	7	7	7	7	.08	6.5	4.0	7	6	.05	mV
Drift (Typ.)	8	5	8 to 10	8 to 10	.2	5	2	20	5	.2	μV/°C
Bias Current	300	70	10 to 40	10 to 40	1	400	400	400	50	1	nA
Offset Current	100	40	7.5 to 20	7.5 to 20	.5	100	120	100	30	.5	nA
Common Mode Range	±13	±11	±10	±10	±10	±12	±12	±10	±11	±10	V
INPUT NOISE (3)											μVRMS
TRANSFER CHARACTERISTICS											
Large Signal Voltage Gain	15K	100K	20K	20K	10^6	15K	75K	25K	100K	10^7	V/V
Common Mode Rejection Ratio	74	80	74	74	120	74	80	80	86	130	dB
Bandwidth (Typ.) (1)	8	1	.01 to 10	.01 to 10	3	3.5	8	16 (3)	1	3	MHz
OUTPUT CHARACTERISTICS											
Output Voltage Swing	±13	±11	±13.5 (3)	±13.5 (3)	±10	±10	±10	±10	±11	±10	V
Output Current (1)	18 (3)	±22 (3)	.5 to 5.0 (3)	.5 to 5.0 (3)	±7	±5	±8	20 (1)	±22 (3)	±10	mA
Full Power Bandwidth (Typ.)	30	50	1.5 to 80 (3)	1.5 to 80	40	2.5	60	500 (3)	50	40	kHz
TRANSIENT RESPONSE			200 to	200 to							
Rise Time (1)	40 (3)	(2)	2,000 (3)	2,000 (3)	200 (3)	75 (3)	50 (3)	20 (3)	(2)	200 (3)	ns
Overshoot (1)	15 (3)	(2)	5 to 15 (3)	5 to 15 (3)	20 (3)	25 (3)	30 (3)	25 (3)	(2)	20 (3)	%
Slew Rate (1)	2	±10	.1 to .8 (3)	.1 to .8	2.5 (3)	±1.6 (3)	±4.0(3)	50	10	2.5 (3)	V/μs
Settling Time (Typ.) (1)	1.5 (3)	5.0	(2)	(2)	(2)	12 (3)	4.2 (3)	1.5 (3)	5.0	(2)	μs
POWER SUPPLY CHARACTERISTICS											
Supply Current (1)	4	0.150	.02 to .2	.02 to .2	5	7.0	6.5	6.0 (1)	0.150	5	mA
Power Supply Rejection Ratio	74	80	76	76	120	80	80	80	86	130	dB
FUNCTIONAL CHARACTERISTICS											
Offset Adjust	Dip. Pkg. Only	Yes	Yes	Yes	No	No	No	No	Yes	No	
Compensation Components	0	0	0	0	3	0	0	OAV >10	0	3	
Output Protection	Yes	Yes	Yes	Yes	Yes	Yes (6)	Yes (6)	Yes	Yes	Yes	

(1) At +25°C
(2) Not applicable or not specified
(3) Typical
(4) $V_{SUPPLY} = \pm 40V$
(5) Dependent upon I_{SET} value
(6) One amplifier may be shorted to ground indefinitely

* To-86 only
† Guaranteed for ±15V supplies and applicable temperature range unless otherwise specified.

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HARRIS SEMICONDUCTOR
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HARRIS OPERATIONAL AMPLIFIERS

Selection Guide for Military Applications

PARAMETER†	-55°C to +125°C												UNITS
	HA-909	PRAM™ HA-2400	S/H HA-2420	HA-2500	HA-2502	HA-2510	HA-2512	HA-2520	HA-2522	HA-2530	HA-2600	HA-2602	
INPUT CHARACTERISTICS													
Offset Voltage	6	7	6	8	10	11	14	11	14	3	6	7	mV
Drift (Typ.)	10	20	5	20	20	20	25	20	25	5	5	5	μV/°C
Bias Current	300(1)	400	400	400	500	400	500	400	500	100	30	60	nA
Offset Current	300	100	100	50	100	50	100	50	100	20	30	60	nA
Common Mode Range	±12	±10	±10	±10	±10	±10	±10	±10	±10	±5	±11	±11	V
INPUT NOISE (1)	5												μVRMS
TRANSFER CHARACTERISTICS													
Large Signal Voltage Gain	25K	25K	25K	15K	10K	7.5K	5K	7.5K	5K	100K	70K	60K	V/V
Common Mode Rejection Ratio	80	80	80	80	74	80	74	80	74	86	80	74	dB
Bandwidth (Typ.) (1)	7	16 (3)	2	12	12	12	12	25	25	20	12	12	MHz
OUTPUT CHARACTERISTICS													
Output Voltage Swing	±12	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	V
Output Current (1)	±20	±20 (1)	±10	±10	±10	±10	±10	±10	±10	±25	±15	±10	mA
Full Power Bandwidth (Typ.) (1)	25	500 (3)	70	500	500	1,000	1,000	1,500	1,500	5,000	75	75	kHz
TRANSIENT RESPONSE													
Rise Time (1)	75	20 (3)	100 (3)	50	50	50	50	50	50	40	60	60	ns
Overshoot (1)	40	25 (3)	20 (3)	40	50	40	50	40	50	45	40	40	%
Slew Rate (1)	±1.2	50 (3)	5 (3)	±25	±20	±50	±40	±100	±80	±280	±4	±4	V/μs
Settling Time (Typ.) (1)	(2)	(3) 1.5		0.33	0.33	0.25	0.25	0.20	0.20	.5	1.5	1.5	μs
POWER SUPPLY CHARACTERISTICS													
Supply Current (1)	2.5	(1) 6.0	5.0	6.0	6.0	6.0	6.0	6.0	6.0	6	3.7	4.0	mA
Power Supply Rejection Ratio	80	80	80	80	74	80	74	80	74	86	80	74	dB
FUNCTIONAL CHARACTERISTICS													
Offset Adjust	Yes*	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	
Compensation Components	0	OAV>10	0	0	0	0	0	OAV>3	OAV>3	1	0	0	
Output Protection	No	Yes	Yes	No	No	No	No	No	No	No	Yes	Yes	

PARAMETER†	-55°C to +125°C											UNITS
	HA-2620	HA-2622	HA-2630	HA-2640	HA-2650	HA-2700	HA-2720	HA-2730	HA-2900	HA-4741	HA-4602	
INPUT CHARACTERISTICS							(5)	(5)				
Offset Voltage	6	7	±300	6	±5	5	5	5	.06	5.0	3.0	mV
Drift (Typ.)	5	5	(2)	15	8	5	8 to 10	8 to 10	.3	5	2	μV/°C
Bias Current	35	60	200	50	200	50	10 to 40	10 to 40	1	325	325	nA
Offset Current	35	60	(2)	35	60	30	7.5 to 20	7.5 to 20	.5	75	125	nA
Common Mode Range	±11	11	±10	±35 (4)	±13	±11	±10	±10	±10	±12	±12	V
INPUT NOISE (1)												μVRMS
TRANSFER CHARACTERISTICS							(5)	(5)				
Large Signal Voltage Gain	70K	60K	.85	75K	20K	100K	25K	25K	10^6	25K	100K	V/V
Common Mode Rejection Ratio	80	74	(2)	80	80	86	80	80	120	74	86	dB
Bandwidth (Typ.) (1)	35	35	8	4	8	1	.01 to 10	.01 to 10	3	3.5	8	MHz
OUTPUT CHARACTERISTICS							(5)	(5)				
Output Voltage Swing	±10	±10	±10	±35 (4)	±13	±11	±13.5 (3)	±13.5 (3)	±10	±10	±10	V
Output Current	±10	±10	±400	±12	20 (3)	±22 (3)	±.5 to 5.0 (3)	±.5 to 5.0 (3)	±10	±5.0	±10	mA
Full Power Bandwidth	600	600	8,000	23	30	50	1.5 to 80 (3)	1.5 to 80 (3)	40	25	60	kHz
TRANSIENT RESPONSE							(5)	(5)				
Rise Time (1)	45	45	30 (3)	60 (3)	40 (3)	(2)	200 to 2,000(3)	200 to 2,000(3)	200 (3)	75	50 (3)	ns
Overshoot (1)	(2)	(2)	25 (3)	15 (3)	15 (3)	(2)	5 to 15 (3)	5 to 15 (3)	20 (3)	25	30 (3)	%
Slew Rate (1)	±25	±20	200	5 (3)	±2	±10	.1 to .8 (3)	.1 to .8 (3)	2.5 (3)	±1.6	±4.0 (3)	V/μs
Settling Time (Typ.) (1)	0.30	0.30	.5 (3)	1.5 (3)	1.5 (3)	5.0	(2)	(2)	(2)	12	4.2 (3)	μs
POWER SUPPLY CHARACTERISTICS							(5)	(5)				
Supply Current (1)	3.7	4.0	20	3.8	3	0.15	.02 to .2	.02 to .2	5	5.0	5.5	mA
Power Supply Rejection Ratio	80	74	66	80	80	86	80	80	120	80	86	dB
FUNCTIONAL CHARACTERISTICS												
Offset Adjust	Yes	Yes	No	Yes	Dip Pkg Only	Yes	Yes	Yes	No	No	No	
Compensation Components	OAV>5	OAV>5	0	0	0	0	0	0	3	0	0	
Output Protection	Yes	Yes	External	Yes	Yes	Yes	Yes	Yes	Yes	Yes (6)	Yes (6)	

(1) At +25°C
(2) Not applicable or not specified
(3) Typical
(4) $V_{SUPPLY} = \pm 40V$
(5) Dependent upon I_{SET} value
(6) One amplifier may be shorted to ground indefinitely

* To-86 only
† Guaranteed for ±15V supplies and applicable temperature range unless otherwise specified.

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HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-4602/4605

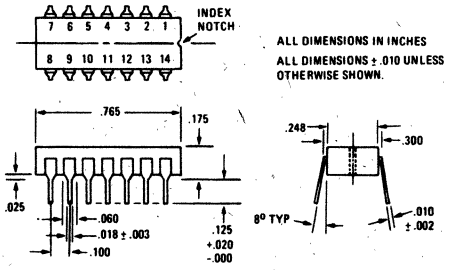
High Performance Quad Operational Amplifier

FEATURES

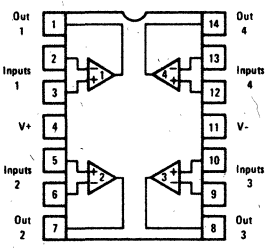
- SLEW RATE — ±4 V/μS (TYP.)
- BANDWIDTH — 8 MHz (TYP.)
- INPUT NOISE VOLTAGE (f = 1KHz) — 8 NV/√Hz (TYP.)
- INPUT OFFSET VOLTAGE — 0.3 mV (TYP.)
- FAST SETTLING (0.01%) — 4.2 μs (TYP.)
- SUPPLY RANGE — ±5V TO + 20V
- LOW POWER CONSUMPTION — 35 mW/AMP
- NO CROSSOVER DISTORTION
- OUTPUT SHORT CIRCUIT PROTECTION

PACKAGE/PINOUT

14 LEAD CERAMIC
D. I. P. (CERDIP)



PINOUT



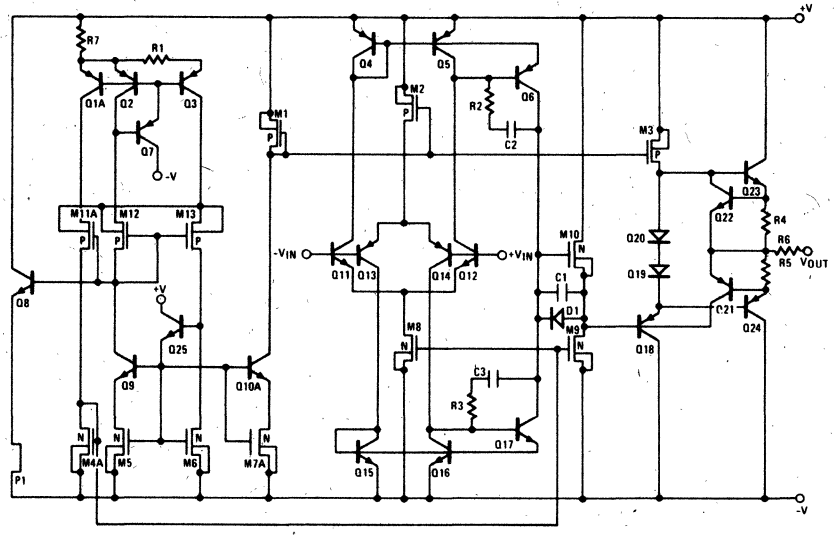
DESCRIPTION

The HA-4602/4605 is a high performance internally compensated quad operational amplifier with eight times the slew rate and bandwidth of the 741 at only three-fifths the quiescent power. Its input characteristics are equally impressive offering high accuracy and stability over temperature in high gain circuits. The input stage is specially designed to have very little offset voltage and temperature coefficient so that cumbersome external nulling circuits are not needed in most applications. Its monolithic construction provides close parameter matching over temperature making it particularly useful in multiple op amp active filter circuits. It is useful in data acquisition where its fast settling (4.2 μs to 0.01%) would be useful in medium speed high accuracy systems. Other applications include, function generators, ocsillators, absolute value circuits, integrators or just any multiple op amp application where high density and high performance is needed.

The HA-4602-2 has guaranteed operation over - 55°C to + 125°C and can be furnished to meet MIL-STD-883 (HA-4602-8). The HA-4605-5 is guaranteed over 0°C to + 75°C. Both are available in 14 lead ceramic dual-in-line packages.

SCHEMATIC DIAGRAM

(¼)
HA-4602/4605



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ABSOLUTE MAXIMUM RATINGS

T_A = +25°C Unless Otherwise Stated

Voltage Between V+ and V- Terminals	40.0V	Power Dissipation (Note 3)	880mW
Differential Input Voltage	±7V	Operating Temperature Range	
Input Voltage (Note 1)	±15.0V	HA-4602-2	$-55^{\circ}C \leq T_A \leq +125^{\circ}C$
Output Short Circuit Duration (Note 2)	Indefinite	HA-4605-5	$0^{\circ}C \leq T_A \leq +75^{\circ}C$
		Storage Temperature Range	$-65^{\circ}C \leq T_A \leq +150^{\circ}C$

ELECTRICAL CHARACTERISTICS

V+ = 15V, V- = -15V

PARAMETER	TEMP.	HA-4602-2 -55°C to +125°C MIN.	TYP.	MAX.	HA-4605-5 0°C to +75°C MIN.	TYP.	MAX.	UNITS
INPUT CHARACTERISTICS								
* Offset Voltage	+25°C		0.3	2.5		0.5	3.5	mV
	Full			3.0			4.0	mV
Av. Offset Voltage Drift	Full		2			2		µV/°C
* Bias Current	+25°C		130	200		130	300	nA
	Full			325			400	nA
* Offset Current	+25°C		30	75		30	100	nA
	Full			125			120	nA
Common Mode Range	Full	±12			±12			V
Input Noise Voltage (f = 1KHz)	+25°C		8			8		$nV/\sqrt{Hz}$
TRANSFER CHARACTERISTICS								
* Large Signal Voltage Gain (Note 4)	Full	100K	250K		75K	250K		V/V
* Common Mode Rejection Ratio (Note 8)	Full	86			80			dB
Channel Separation (Note 5)	+25°C		-108			-108		dB
Small Signal Bandwidth	+25°C		8			8		MHz
OUTPUT CHARACTERISTICS								
* Output Voltage Swing (R_L = 10K)	Full	±12	±13		±12	±13		V
(R_L = 2K)	Full	±10	±12		±10	±12		V
Full Power Bandwidth (Note 4)	+25°C		60			60		KHz
Output Current (Note 6)	Full	±10	±15		±8	±15		mA
Output Resistance	+25°C		200			200		Ω
TRANSIENT RESPONSE (Note 7)								
Rise Time	+25°C		50			50		ns
Overshoot	+25°C		30			30		%
Slew Rate	+25°C		±4			±4		V/µs
Settling Time (Note 9)			4.2			4.2		µs
POWER SUPPLY CHARACTERISTICS								
* Supply Current (I^+ or I^-)	+25°C		4.6	5.5		5.0	6.5	mA
* Power Supply Rejection Ratio (Note 8)	Full	86			80			dB

NOTES:
1. For supply voltages less than +15V, the absolute maximum input voltage is equal to the supply voltage.
2. One amplifier may be shorted to ground indefinitely.
3. Derate 5.8mW/°C above T_A = + 25°C.
4. V_{OUT} = + 10, R_L = 2K.
5. Referred to input; f = 10KHz, R_S = 1K
6. V_{OUT} = +5.
7. See pulse response characteristics.
8. Δ V = + 5.0V.
9. To 0.01% for 10V input step and Av =-1. See settling characterisitics.

* 100% Tested for DASH 8.

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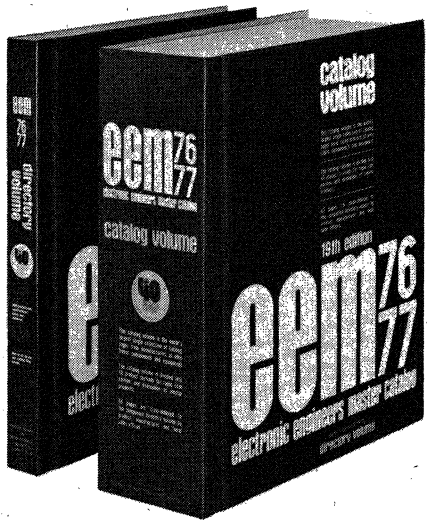

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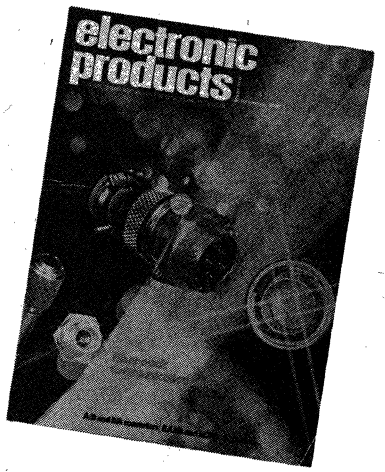

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*4156	3301/3401
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2900/3900	*3403A/3503A

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RAYTHEON

SEMICONDUCTOR DIVISION

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Quad Operational Amplifiers

3403A
3503A

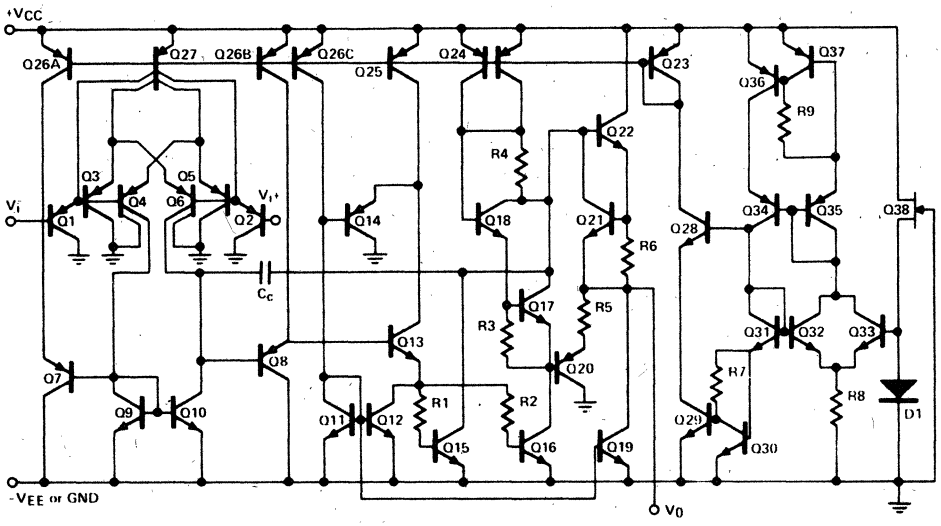
GENERAL DESCRIPTION

The 3403A high performance quad op-amp features improved large signal bandwidth and worst case DC specs equal to or better than the standard 741 type general purpose op-amp. The device uses a newly developed type of ground-sensing differential input stage which provides increased slew rate.

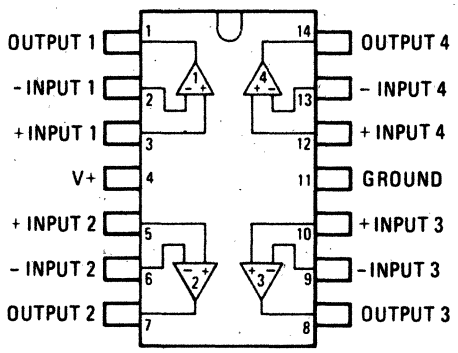
DESIGN FEATURES

- Class AB Output State; No Crossover Distortion
- Output Voltage Swings to Ground in Single Supply Operations
- High Slew Rate 1.2 V/μs
- Single or Split Supply Operation
- Wide Supply Operation 2.5 V to +36 V or ±1.25 V to ±18 V
- Pin Compatible with LM324 and 3403
- Low Power Consumption 0.8 mA/amplifier

SCHEMATIC DIAGRAM



CONNECTION INFORMATION



DB and DC
Dual In-line Packages
(Top View)

Order Part Nos.:
RC3403ADB, RC3403ADC, RV3403ADB, RV3403ADC, RM3503ADC

RAYTHEON
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ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V^+ . . . . . 36 V or ±18 V
Differential Input Voltage . . . . . 36 V
Input Voltage . . . . . -0.3 V to +36 V
Power Dissipation
"DB" package . . . . 500 MW (molded DIP epoxy "B")
"DC" package . . . . . 650 mW (hermetic DIP)

Operating Temperature Range
RM3503A . . . . . -55°C to +125°C
RC3403A . . . . . 0°C to +70°C
RV3403A . . . . . -40°C to +85°C
Storage Temperature Range . . . . . -65°C to +150°C
Lead Temperature (Soldering, 60s) . . . . . 300°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_{CC} = ±15V unless otherwise noted)

PARAMETER	CONDITIONS	RM3503A			RC/RV3403A			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	R_S = 0		2	4*		2	6*	mV
Input Offset Current	I_{in-} or I_{in+}		±30	±50		±30	±50	nA
Input Bias Current	I_{in-} or I_{in+}		-150	-400*		-150	-500	nA
Input Common Mode Voltage Range		0		V^+ - 2	0		V^+ - 2	V
Supply Current	R_L = ∞ on all op-amps		3	4		3	5*	mA
Large Signal Voltage Gain	R_L > 2KΩ	50	100		25*	100		V/mV
Output Voltage Swing	R_L = 2KΩ	±13	±14		±13	±14		V
Common Mode Rejection Ratio	DC	70	90		70	90		dB
Channel Separation	±1kHz to 20 kHz (in ref)		-120			-120		dB
Output Source Current	V_{IN+} = 1 V V_{IN-} = 0 V	20	40		20	40		mA
Output sink current		10	20		10	20		mA
Small signal bandwidth			1			1		MHz
Slew Rate	A_V = 1, -10<V_i<+10		1.2*			1.2*		V/μs
Distortion (Crossover)	f = 20 kHz, VO = $10V_{pp}$		1			1		%
Power Bandwidth	VO = $10V_{pp}$		40			40		kHz
Power Supply Rejection Ratio			20	50		20	100	μV/V

*Significantly inproved performance

ELECTRICAL CHARACTERISTICS GUARANTEED OVER TEMPERATURE

Range: RM3503A: -55°C to +125°C
RC3403A: 0°C to +70°C
RV3403A: -40°C to +85°C

PARAMETER	RM3503A		RC3403A		RV3403A		UNITS
	MIN	MAX	MIN	MAX	MIN	MAX	
Input Offset Voltage	–	6.0	–	10.0	–	10.0	mV
Input Offset Current	–	200	–	200	–	200	nA
Input Bias Current	–	-1500	–	-800	–	-1500	nA
Large Signal Voltage Gain	25	–	15	–	15	–	V/mV
Output Voltage Swing	±10	–	±10	–	±10	–	V

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GENERAL DESCRIPTION

The RM4136 and RC4136 include four independent high gain operational amplifiers internally compensated and constructed on a single silicon chip using the planar epitaxial processes.

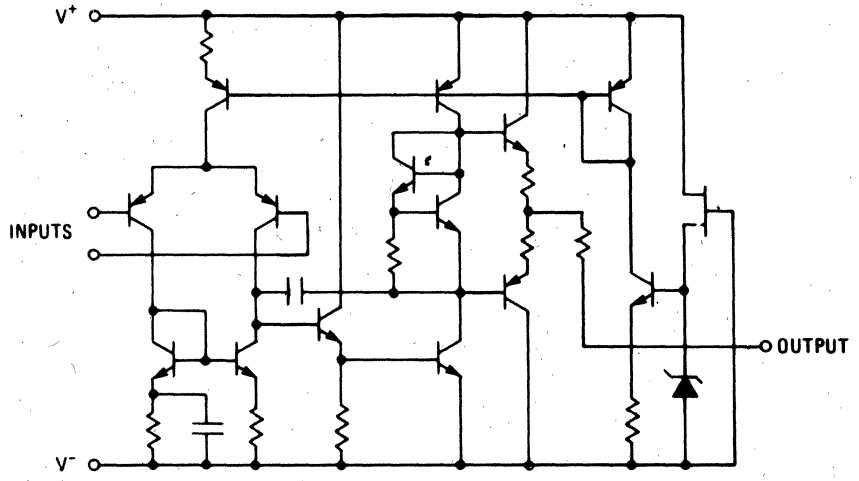
These amplifiers meet or exceed all specifications for 741 type amplifiers. Excellent channel separation allows the use of the 4136 quad amplifier in all 741 operational amplifier applications providing the highest possible packaging density.

The specially designed low noise input transistors allow the 4136 to be used in low noise signal processing applications such as audio preamplifiers and signal conditioners.

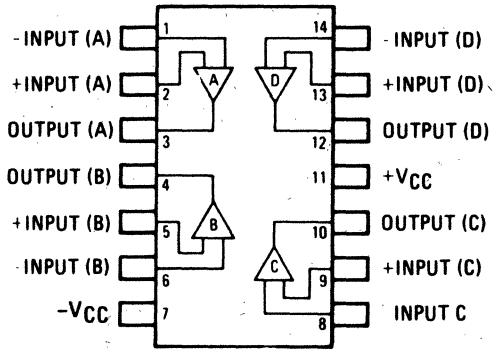
DESIGN FEATURES

- Unity Gain Bandwidth, 3MHz
- Continuous Short Circuit Protection
- No Frequency Compensation Required
- No Latch-up
- Large Common Mode and Differential Voltage Ranges
- Low Power Consumption
- Parameter Tracking Over Temperature Range
- Gain and Phase Match Between Amplifiers

SCHEMATIC DIAGRAM



CONNECTION INFORMATION



DC and DB
Dual In-line Packages
(Top View)

Order Part Nos.:
RM4136DC, RV4136 DB,
RC4136DC, RC4136DC

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ABSOLUTE MAXIMUM RATINGS

Supply Voltage . . . . . RM4136: ±22V
RV4136, RC4136: ±18V
Internal Power Dissipation (Note 1) 800mW
Differential Input Voltage . . . . . ±30V
Input Voltage (Note 2) . . . . . ±15V

Storage Temperature Range . . . . . −65°C to +150°C
Operating Temperature Range . . RM4136: −55°C to +125°C
RC4136: 0°C to +70°C
RV4136: −40°C to +85°C
Lead Temperature (Soldering, 60s) . . . . . 300°C
Output Short-Circuit Duration (Note 3) . . . . . Indefinite

ELECTRICAL CHARACTERISTICS (V_{CC} = ±15V, T_A = +25°C unless otherwise noted.)

PARAMETER	CONDITIONS	RM4136			RV4136, RC4136			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	$R_S \leq 10$ kΩ		0.5	4.0		0.5	6.0	mV
Input Offset Current			5.0	150		5.0	200	nA
Input Bias Current			40	400		40	500	nA
Input Resistance		0.3	5.0		0.3	5.0		MΩ
Large-Signal Voltage Gain	$R_L \geq 2$ kΩ V_{out} = ±10V	50,000	300,000		20,000	300,000		V/V
Output Voltage Swing	$R_L \geq 10$ kΩ	±12	±14		±12	±14		V
	$R_L \geq 2$ kΩ	±10	±13		±10	±13		V
Input Voltage Range		±12	±14		±12	±14		V
Common Mode Rejection Ratio	$R_S \leq 10$ kΩ	70	100		60	100		dB
Supply Voltage Rejection Ratio	$R_S \leq 10$ kΩ		10	150		10	150	μV/V
Power Consumption	$R_L = \infty$, All Outputs		210	340		210	340	mW
Transient Response (unity gain) V_{in} = 20 mV R_L = 2 kΩ $C_L \leq 100$ pF								
Risetime			0.13			0.13		μs
Overshoot			5.0			5.0		%
Unity Gain Bandwidth			3.0			3.0		MHz
Slew Rate (unity gain)	$R_L \geq 2$ kΩ		1.5			1.0		V/μs
Channel Separation (open loop) (Gain = 100)	f = 10 kHz R_S = 1 kΩ		105			105		dB
	f = 10 kHz R_S = 1 kΩ		105			105		dB
The following specifications apply for −55°C ≤ T_A ≤ +125°C for RM4136; 0°C ≤ T_A ≤ +70°C for RC4136.								
Input Offset Voltage	$R_S \leq 10$ kΩ			6.0			7.5	mV
Input Offset Current				500			300	nA
Input Bias Current				1500			800	nA
Large-Signal Voltage Gain	$R_L \geq 2$ kΩ V_{out} = ±10V	25,000			15,000			V/V
Output Voltage Swing	$R_L \geq 2$ kΩ	±10			±10			V
Power Consumption	T_A = High		180	300		180	300	mW
	T_A = Low		240	400		240	400	mW

NOTES:
1. Rating applies for case temperature to +25°C; derate linearly at 6.4 mW/°C for ambient temperatures above +25°C.
2. For supply voltages less than ±15V the absolute maximum input voltage is equal to the supply voltage.
3. Short-circuit may be to ground or one amplifier only. I_{CC} = 45mA (typical).

RAYTHEON

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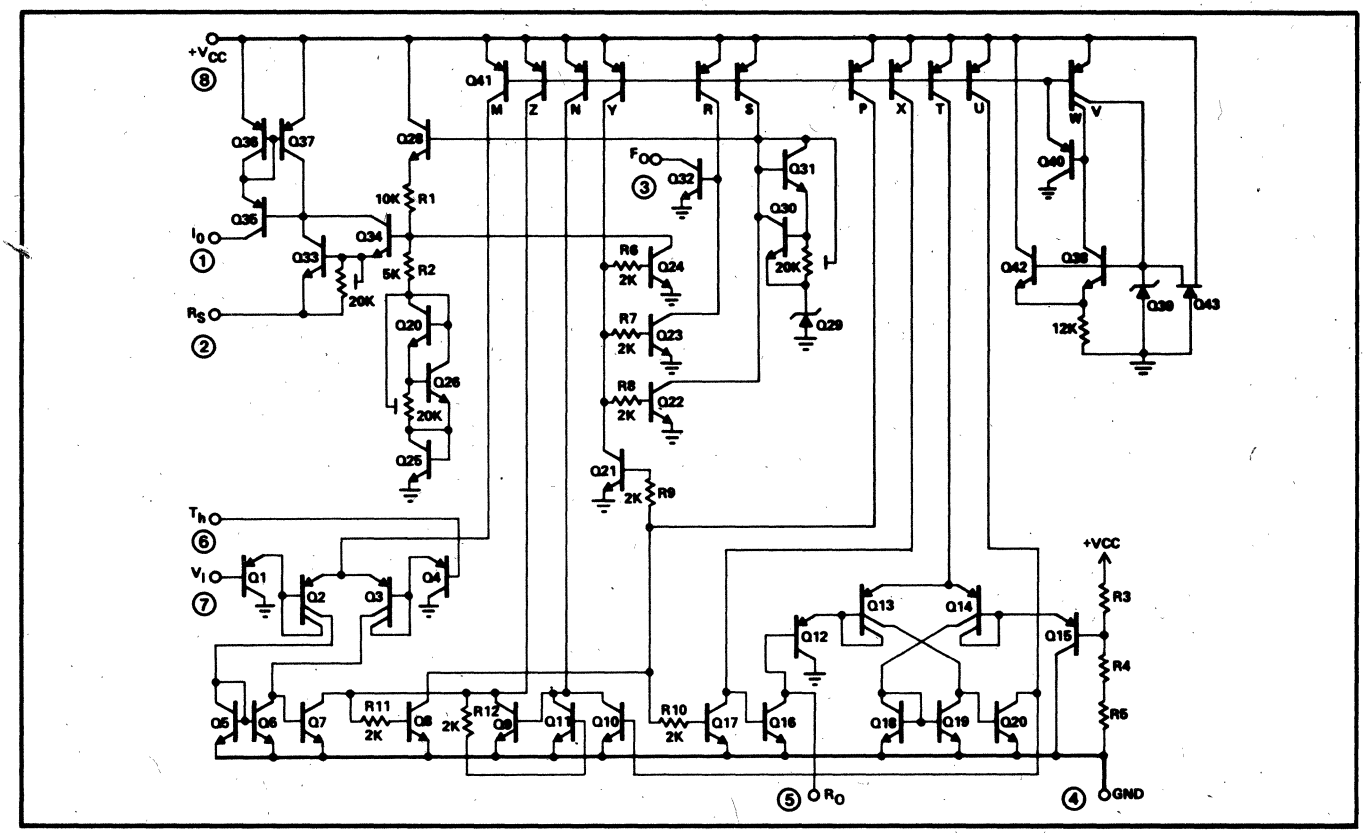
GENERAL DESCRIPTION

The RC4151 and RM4151 provide a simple low-cost method of A/D conversion. They have all the inherent advantages of the voltage-to-frequency conversion technique. The output of RC4151/RM4151 is a series of pulses of constant duration. The frequency of the pulses is proportional to the applied input voltage. These converters are designed for use in a wide range of data conversion and remote sensing applications.

DESIGN FEATURES

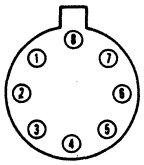
- Single Supply Operation (+8V to +22V)
- Pulse Output Compatible With All Logic Forms
- Programmable Scale Factor (K)
- Linearity ±0.05% typical—precision mode
- Temperature stability ±100% ppm/°C typical
- High Noise Rejection
- Inherent Monotonicity
- Easily Transmittable Output
- Simple Full Scale Trim
- Single-Ended Input, Referenced to Ground
- Also Provides Frequency-to-Voltage Conversion

SCHEMATIC DIAGRAM



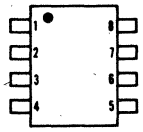
CONNECTION INFORMATION

TE (TO-99) METAL CAN
(Top View)



Order Part Nos.: RC4151T, RM4151T
NOTE: PIN 4 CONNECTED TO CASE

NB MINIATURE
DUAL-IN-LINE
(Top View)



Order Part Nos.: RC4151NB, RV4151NB

PIN	FUNCTION
1	CURRENT SOURCE
2	SCALE FACTOR
3	LOGIC OUTPUT
4	GROUND
5	ONE-SHOT R, C
6	THRESHOLD
7	INPUT VOLTAGE
8	V_{CC}

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ABSOLUTE MAXIMUM RATINGS

Supply Voltages . . . . . +8.0 to +22V
Output Sink Current 20mA
Internal Power Dissipation 500mW
Input Voltage . . . . . -0.2V to +V_{CC}
Output Short Circuit to Ground . . . . . Continuous

Storage Temperature Range
RM4151 . . . . . -65°C to +150°C
RV4151 . . . . . -55°C to +125°C
RC4151 . . . . . -55°C to +125°C
Operating Temperature Range
RM4151 . . . . . -55°C to +125°C
RV4151 . . . . . -40°C to +85°C
RC4151 . . . . . 0°C to +70°C

ELECTRICAL CHARACTERISTICS (V_{CC} = +15V, T_A = +25°C, unless otherwise specified)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Current	8V < V_{CC} < 15V	2.0	3.5	6.0	mA
	15V < V_{CC} < 22V	2.0	4.5	7.5	mA
Conversion Accuracy Scale Factor	Circuit Figure 3, V_I = 10V R_S = 14.0k	0.90	1.00	1.10	kHz/V
Drift with Temperature	Circuit Figure 3, V_I = 10V	–	±100	–	ppM/°C
Drift with V_{CC}	Circuit Figure 3, V_I = 1.0V 8V < V_{CC} < 18V	–	0.2	1.0	%/V
Input Comparator Offset Voltage		–	5	10	mV
Offset Current		–	±50	±100	nA
Input Bias Current		–	-100	-300	nA
Common Mode Range (Note 1)		0	0 to V_{CC} -2	V_{CC} -3.0	V
One-Shot Threshold Voltage, Pin 5		0.63	.667	0.70	x V_{CC}
Input Bias Current, Pin 5		–	-100	-500	nA
Reset V_{SAT}	Pin 5, I = 2.2mA	–	0.15	0.50	V
Current Source Output Current (R_S = 14.0kΩ)	Pin 1, Figure 2, V = 0	–	138.7	–	μA
Change with Voltage	Pin 1, V = 0V to V = 10V	–	1.0	2.5	μA
Off Leakage	Pin 1, V = 0V	–	1	50.0	nA
Reference Voltage	Pin 2, Figure 2	1.70	1.9	2.08	V
Logic Output V_{SAT}	Pin 3, I = 3.0mA	–	0.15	0.50	V
V_{SAT}	Pin 3, I = 2.0mA	–	0.10	0.30	V
Off Leakage		–	.1	1.0	μA

Note 1: Input Common Mode Range includes ground.

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DESCRIPTION

The RM4156/RC4156 is a monolithic integrated circuit, consisting of four independent high performance operational amplifiers constructed with the planar epitaxial process.

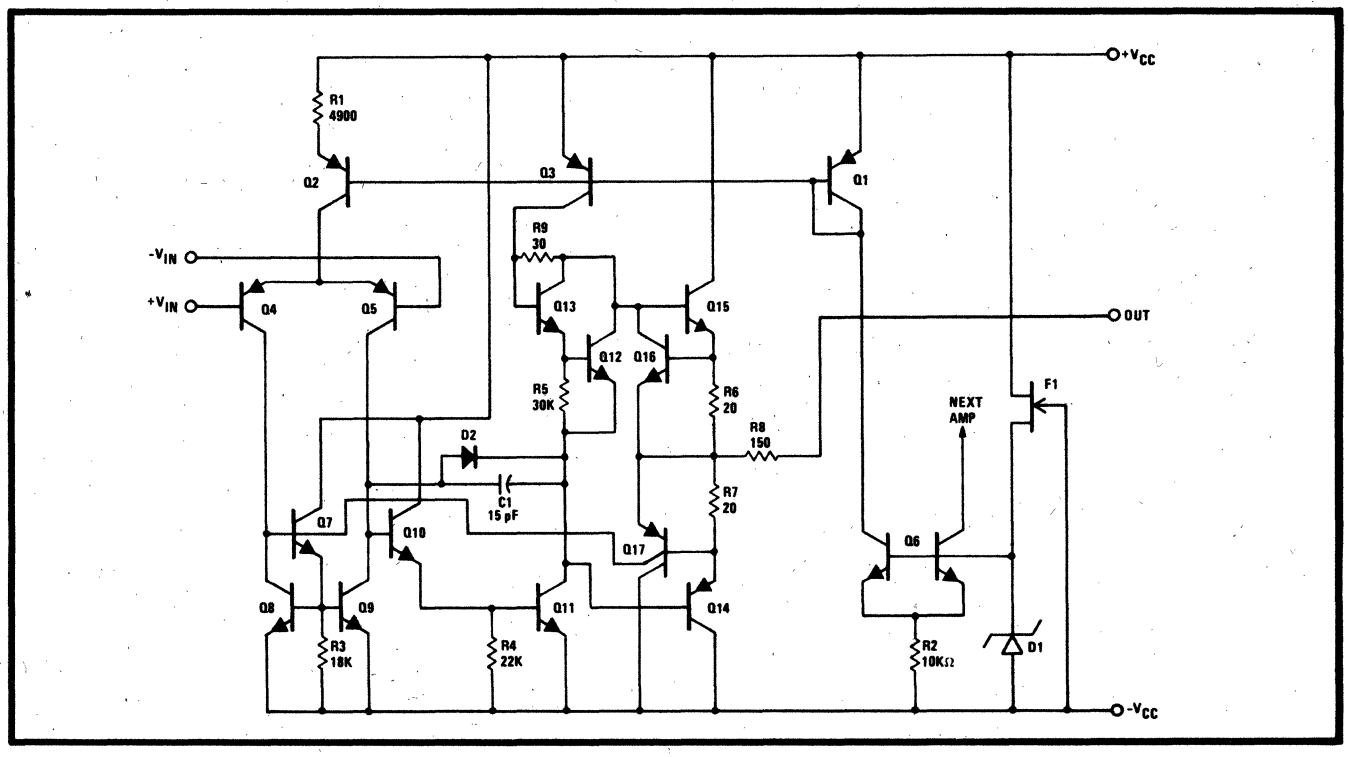
These amplifiers feature guaranteed A.C. performance which far exceeds that of the 741 type amplifiers. Also featured are excellent input characteristics and guaranteed low noise making this device the optimum choice for audio, active filter and instrumentation applications.

FEATURES

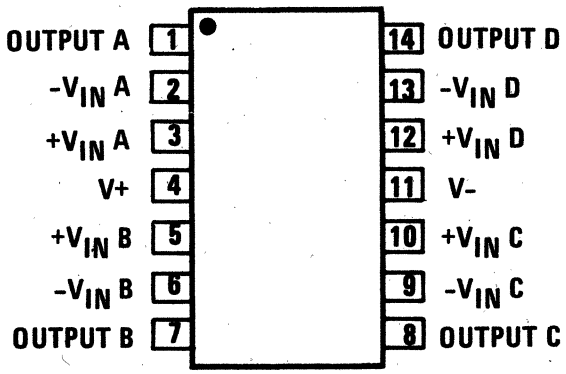
	Typical	Guaranteed
• Unity Gain Bandwidth	3.5 MHz	2.8 MHz
• High Slew Rate	1.6V/μS	1.3V/μS
• Low Noise Voltage	0.8μV	2.0μV

- Indefinite Short Circuit Protection
- No Crossover Distortion
- Low Input Offset and Bias Parameters
- Internal Compensation

SCHEMATIC DIAGRAM



CONNECTION INFORMATION



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ABSOLUTE MAXIMUM RATINGS

Supply Voltage	±20V	Storage Temperature Range	-65 to +150°C
Internal Power Dissipation (Note 1)	880 mW	Operating Temperature Range RM4156	-55 to +125°C
Differential Input Voltage	±30V	RV4156	-40 to +85°C
Input Voltage (Note 2)	±15V	RC4156	0 to +70°C
Output Short Circuit Duration (Note 3)	Indefinite	Lead Soldering Temperature (60 sec)	300°C

ELECTRICAL CHARACTERISTICS V_{CC} ±15V T_A +25°C unless otherwise specified

PARAMETER	CONDITIONS	RM4156 MIN	RM4156 TYP	RM4156 MAX	RV4156/RC4156 MIN	RV4156/RC4156 TYP	RV4156/RC4156 MAX	UNITS
Input Offset Voltage	$R_S \leq 10$ KΩ		0.5	3.0		1.0	5.0	mV
Input Offset Current			15	30		30	50	nA
Input Bias Current			60	200		60	300	nA
Input Resistance			5			5		MΩ
Large Signal Voltage Gain	$R_L \geq 2$ KΩ V_{OUT} ±10V	50,000	100,000		25,000	100,000		V/V
Output Voltage Swing	$R_L \geq 10$ KΩ	±12	±14		±12	±14		V
	$R_L \geq 2$ KΩ	±10	±13		±10	±13		V
Input Voltage Range		±12	±14		±12	±14		V
Output Resistance			230			230		Ω
Output Short Circuit Current			25			25		mA
Common Mode Rejection Ratio	$R_S \leq 10$ KΩ	80			80			dB
Power Supply Rejection Ratio	$R_S \leq 10$ KΩ	80			80			dB
Supply Current (all amplifiers)	$R_L = \infty$		4.5	5.0		5.0	7.0	mA
Transient Response								
Rise Time			50			75		ns
Overshoot			25%			25%		%
Slew Rate		1.3	1.6		1.3	1.6		V/μs
Unity Gain Bandwidth		2.8	3.5		2.8	3.5		MHz
Phase Margin	R_L = 2 KΩ R_C = 50 pF		50			50		degrees
Full Power Bandwidth	V_O = 20V p-p	20	25		20	25		kHz
Input Noise Voltage	f = 20 Hz to 20 kHz		0.8	2.0		0.8	2.0	μV RMS
Input Noise Current	f = 20 Hz to 20 kHz		15			15		pA RMS
Channel Separation			108			108		dB
The following specifications apply for -55°C ≤ T_A ≤ +125°C for RM4156, -40°C ≤ T_A ≤ +85°C for RV4156, 0°C ≤ T_A ≤ +70°C for RC4156.								
Input Offset Voltage	$R_S \leq 10$ KΩ			5.0			6.5	mV
Input Offset Current				75			100	nA
Input Bias Current				325			400	nA
Large Signal Voltage Gain	$R_L \geq 2$ KΩ V_{OUT} ±10V	25,000			15,000			V/V
Output Voltage Swing	$R_L \geq 2$ KΩ	±10			±10			V
Supply Current			10			10		mA
Average Offset Voltage Drift			5			5		μV/°C

Notes: 1. Rating applies for case temperature of +25°C maximum; derate linearity at 6.4 mW/°C for temperatures above +25°C.
2. For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.
3. Short circuit to ground on one amplifier only.

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Dual Tracking Voltage Regulators 4194

GENERAL DESCRIPTION

The RM4194 and RC4194 are dual polarity tracking regulators designed to provide balanced or unbalanced positive and negative output voltages at currents to 200mA. A single external resistor adjustment can be used to change both outputs between the limits of ±50mV and ±42V.

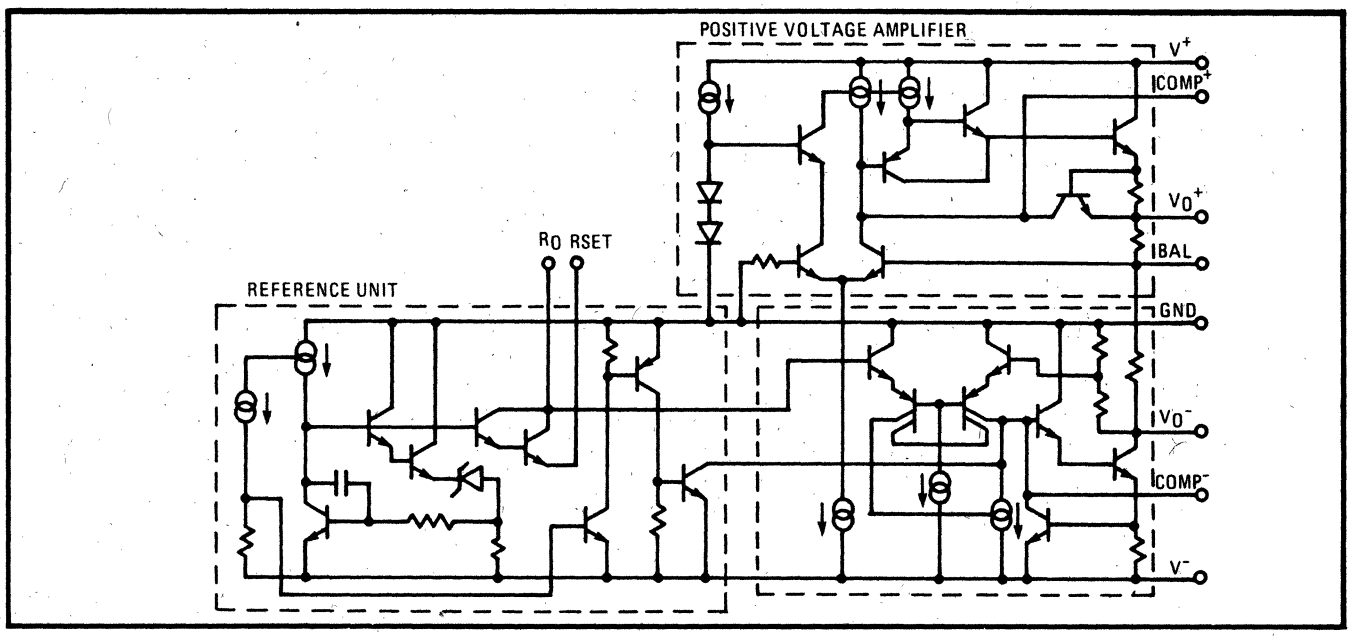
These devices are designed for local "on-card" regulation, eliminating distribution problems associated with single-point regulation. To simplify application the regulators require a minimum number of external parts.

The device is available in two package types to accommodate various power requirements. The TK (TO-66) power package can dissipate up to 3W at $T_A = 25°C$. The D 14-pin dual in-line will dissipate up to 900mW.

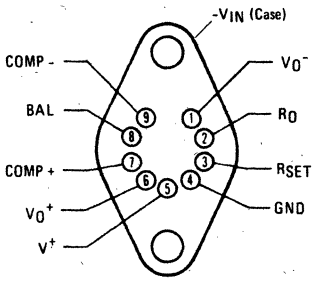
DESIGN FEATURES

- Simultaneously Adjustable Outputs With One Resistor to ±42V
- Load Current ±200mA with 0.2% Load Regulation
- Internal Thermal Shutdown at $T_j = 175°C$
- External Balance for $\pm V_O$ Unbalancing
- 3W Power Dissipation

SCHEMATIC DIAGRAM

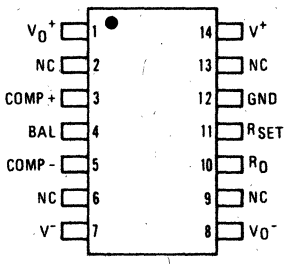


CONNECTION INFORMATION



TK (TO-66) Package
(Bottom View)

Order Part Nos.:
RC4194TK, RM4194TK



DC Dual In-line Package
(Top View)

Order Part Nos.:
RC4194DC, RM4194DC

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ABSOLUTE MAXIMUM RATINGS

Input Voltage ±V to Ground ..... RM4194: ±45V
RC4194: ±35V
Input-Output Voltage Differentail ..... RM4194: ±45V
RC4194: ±35V
Power Dissipation at T_A = 25°C
D Package 900mW
TK Package 3.0W

Load Current
D Package 150mA
TK Package 250mA
Operation Junction Temperature Range
RM4194 ..... −55°C to +150°C
RC4194 ..... 0°C to +125°C
Storage Temperature Range ..... −65°C to +150°C
Lead Temperature (Soldering, 10s) ..... +300°C

ELECTRICAL CHARACTERISTICS ($\pm 5 \leq V_{OUT} \leq V_{MAX}$; RM4194: $-55°C \leq T_j \leq +125°C$; RC4194: $0°C \leq T_j \leq +70°C$)

PARAMETER	CONDITIONS	RM4194			RC4194			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Line Regulation	$\Delta V_{IN} = 0.1 V_{IN}$		0.04	0.1		0.04	0.1	$\%V_{OUT}$
Load Regulation	4194TK: I_L = 1 to 200mA 4194DC: I_L = 1 to 100mA, T_A = +25°C		0.001	0.001		0.002	0.004	$\%V°/mA$
	RM4194 = t_j = -55°C – +125°C RC4194 = t_j = 0°C – +70°C		0.002	0.004		0.002	0.004	$\%V°/mA$
TC of Output Voltage			0.002	0.015		0.002	0.015	%/°C
TC of Output Voltage			0.002	0.015		0.003	0.015	%/°C
Stand-By Current Drain (Note 1)	$V_{IN} = V_{MAX}$, V_o = 0V		+0.3	+1.0		+0.3	+1.5	mA
	$V_{IN} = V_{MAX}$, V_o = 0V		−1.2	−2.0		−1.2	−3.0	
Input Voltage Range		±9.5		±45	±9.5		±35	V
Output Voltage Scale Factor	R_{set} = 71.5K, T_j = 25°C	2.42	2.5	2.58	2.38	2.5	2.62	KΩ/V
Output Voltage Range	R_{set} = 71.5K	0.05		±42	0.05		±32	V
Output Voltage Tracking				1.0			2.0	%
Ripple Rejection	f = 120Hz, T_j = 25°C		70			70		dB
Input-Output Voltage Differential	I_L = 50mA T_A = +25°C	3.0			3.0			V
Output Short Circuit Current	V_{IN} = ±30V Max.		300			300		mA
Output Noise Voltage	C_L = 4.7μF, V_o = ±15V f = 10Hz to 100KHz		250			250		μV RMS
Internal Thermal Shutdown			175			175		°C

THERMAL CHARACTERISTICS

PARAMETER	CONDITIONS	PACKAGE	
		DC	TK (TO-66)
Power Dissipation	T_A = 25°C	1W	3W
	T_C = 25°C	2.2W	17.5W
Thermal Resistance	Junction to Ambient, θ_{J-A}	128°C/W	41.6°C/W
	Junction to Case, θ_{J-C}	55°C/W	7.15°C/W

NOTE:
$\pm I_{Quiescent}$ will increase by $50\mu A/V_{OUT}$ on positive side and $100\mu A/V_{OUT}$ on negative side.

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GENERAL DESCRIPTION

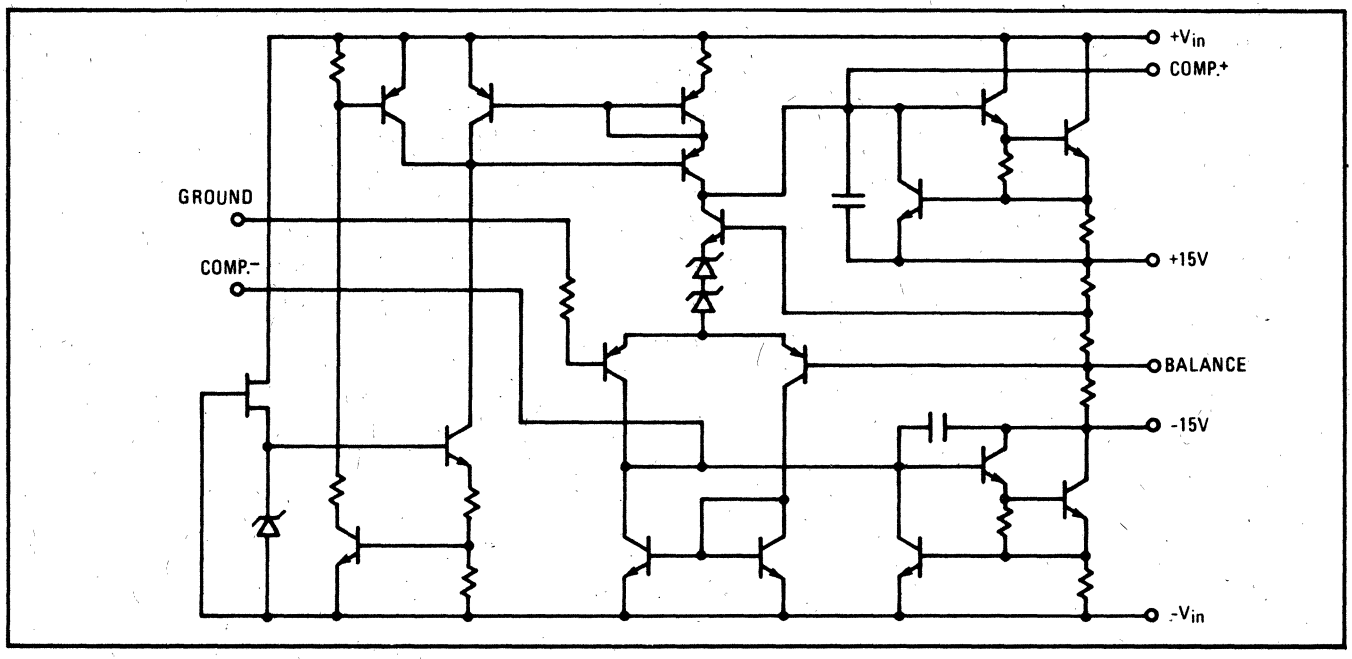
The RM4195 and RC4195 are dual polarity tracking regulators designed to provide balanced positive and negative 15V output voltages at currents to 100mA. These devices are designed for local "on-card" regulation eliminating distribution problems associated with single point regulation. The regulator is intended for ease of application. Only two external components are required for operation (two 10μF bypass capacitors).

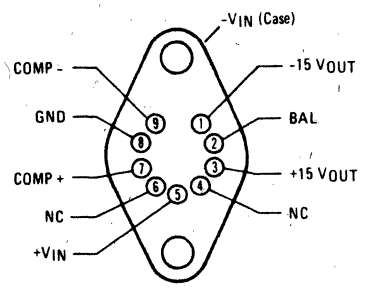
The device is available in three package types to accommodate various applications requiring economy, high power dissipation, and reduced component density.

DESIGN FEATURES

- ±15V Operational Amplifier Power at Reduced Cost and Component Density
- Thermal Shutdown at T_j = +175°C in Addition to Short- Circuit Protection
- Output Currents to 100mA
- May be Used as Single Output Regulator with up to +50V Output
- Available in TO-66, TO-99, and 8-Pin Plastic Mini-DIP

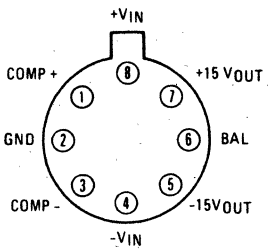
SCHEMATIC DIAGRAM





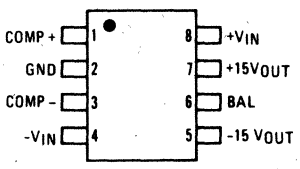
TK (TO-66) Power Package
(Bottom View)

Order Part Nos.:
RC4195TK, RM4195TK



TE Metal Can Package
(Top View)

Order Part Nos.:
RC4195T, RM4195T



NB Dual In-line
(Top View)

Order Part No.:
RC4195NB

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ABSOLUTE MAXIMUM RATINGS

Input Voltage ±V to Ground . . . . . ±30V
Power Dissipation @ T_A = +25°C
TK Package 2.4W
T Package 800mW
NB Package 600mW
Load Current
TK Package 150mA
T, and NB Package 100mA

Operating Junction Temperature Range
RM4195 . . . . . −55°C to +150°C
RC4195 . . . . . 0°C to +125°C
Storage Temperature Range
RM4195 . . . . . -65°C to +150°C
RC4195 . . . . . -65°C to +150°C
Lead Temperature (Soldering, 10s) . . . . . +300°C

ELECTRICAL CHARACTERISTICS (I_L = 1mA, V_{CC} = ±20V, C_L = 10μF unless otherwise specified)

PARAMETER	CONDITIONS	RM4195			RC4195			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Line Regulation	V_{IN} = ±18 to ±30V		2	20		2	20	mV
Load Regulation	I_L = 1 to 100mA		5	30		5	30	mV
Output Voltage Temperature Stability			0.005	0.015		0.005	0.015	%/°C
Standby Current Drain	V_{IN} = ±30V, I_L = 0mA		±1.5	±2.5		±1.5	±3.0	mA
Input Voltage Range		18		30	18		30	V
Output Voltage	T_j = +25°C	14.8	15	15.2	14.5	15	15.5	V
Output Voltage Tracking			±50	±150		±50	±300	mV
Ripple Rejection	f = 120Hz, T_j = +25°C		75			75		dB
Input-Output Voltage Differential	I_L = 50mA	3			3			V
Short-Circuit Current	T_j = +25°C		220			220		mA
Output Noise Voltage	T_j = +25°C, f = 100Hz to 10kHz		60			60		μV RMS
Internal Thermal Shutdown			175			175		°C

THERMAL CHARACTERISTICS

PARAMETER	CONDITIONS	PACKAGE			UNITS
		NB	T (TO-99)	TK (TO-66)	
Power Dissipation	T_A = 25°C	0.6	0.8	2.4	W
	T_C = 25°C		2.1	9	
Thermal Resistance	θ_{J-C}		70	17	°C/W
	θ_{J-A}	210	185	62	

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DESCRIPTION

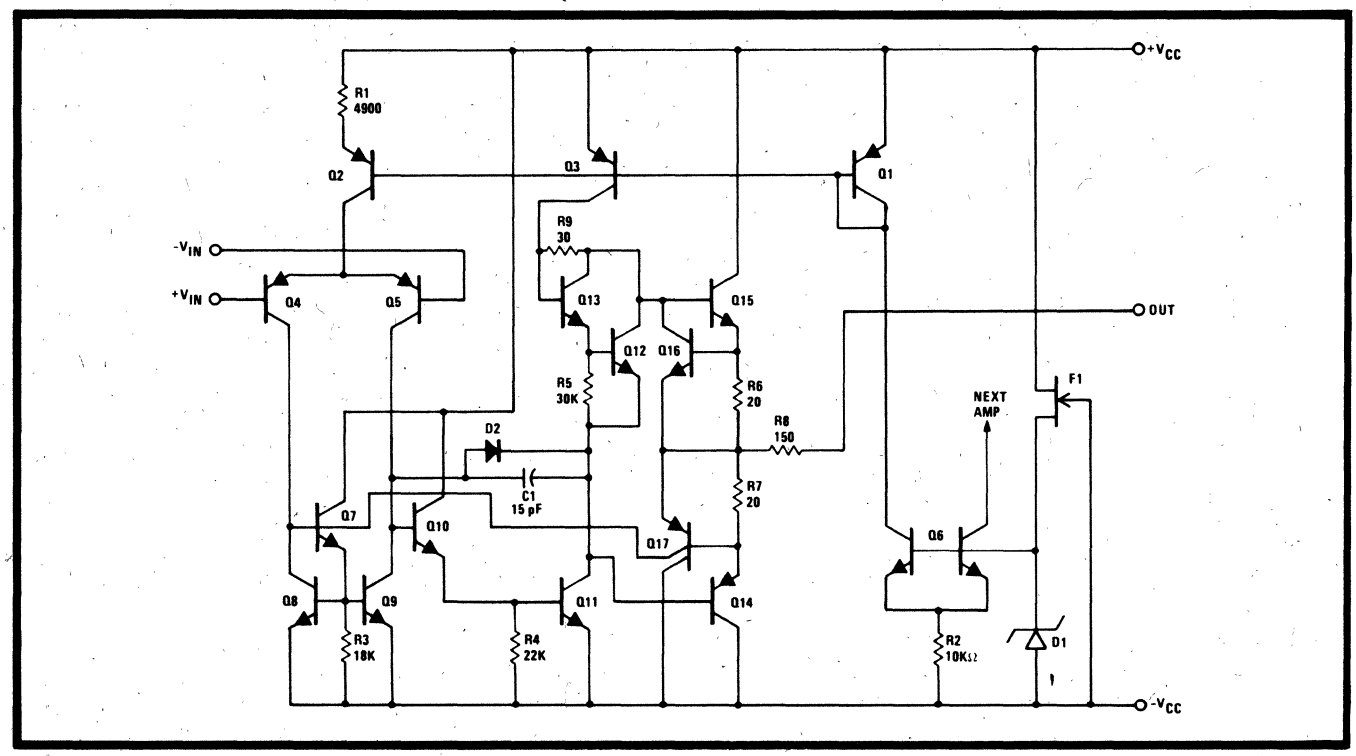
The HA-4741 is a monolithic integrated circuit, consisting of four independent operational amplifiers constructed with the planar epitaxial process.

These amplifiers feature AC and DC performance which exceed that of the 741 type amplifiers. Its superior bandwidth, slew rate and noise characteristics make it an excellent choice for active filter or audio amplifier applications.

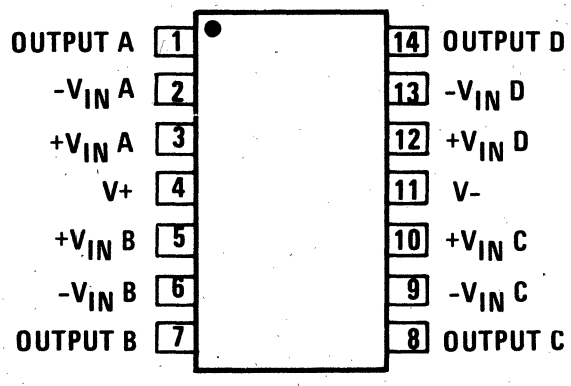
FEATURES

- Unity Gain Bandwidth 3.5 MHz (typical)
- High Slew Rate 1.6V/μS (typical)
- Low Noise Voltage 9nV/$\sqrt{Hz}$ (typical)
- Input Offset Voltage 0.5mV (typical)
- Input Bias Current 60nA (typical)
- Indefinite Short Circuit Protection
- No Crossover Distortion
- Internal Compensation
- Wide Power Supply Range ±2V to ±20V

SCHEMATIC DIAGRAM



CONNECTION INFORMATION



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ABSOLUTE MAXIMUM RATINGS

Supply Voltage . . . . . ±20V
Internal Power Dissipation (Note 1) . . . . 880 mW
Differential Input Voltage . . . . . ±30V
Input Voltage (Note 2) . . . . . ±15V
Output Short Circuit Duration (Note 3) . . . Indefinite
Storage Temperature Range . . . . . -65 to +150°C
Operating Temperature Range
HA-4741-2 . . . . . -55 to +125°C
HA-4741-5 . . . . . 0 to +70°C
Lead Soldering Temperature (60 sec) . . . . 300°C

ELECTRICAL CHARACTERISTICS V_{CC} ±15V T_A +25°C unless otherwise specified

PARAMETER	CONDITIONS	HA-4741-2			HA-4741-5			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	$R_S \leq 10$ KΩ		0.5	3.0		1.0	5.0	mV
Input Offset Current			15	30		30	50	nA
Input Bias Current			60	200		60	300	nA
Input Resistance			5			5		MΩ
Large Signal Voltage Gain	$R_L \geq 2$ KΩ V_{OUT} ±10V	50,000	100,000		25,000	50,000		V/V
Input Voltage Range		±12			±12			V
Output Resistance		300			300			Ω
Output Current	V_{OUT} ±10V	±5	±15		±5	±15		mA
Common Mode Rejection Ratio	$R_S \leq 10$ KΩ ΔV = ±5V	80			80			dB
Supply Current (all amplifiers)	$R_L = \infty$		4.5	5.0		5.0	7.0	mA
Transient Response								
Rise Time			75			75		ns
Overshoot			25%			25%		%
Slew Rate			1.6			1.6		V/μs
Unity Gain Bandwidth			3.5			3.5		MHz
Full Power Bandwidth	V_O = 20V p-p R_L = 2K		25			25		kHz
Input Noise Voltage	f = 1 kHz		9			9		nV/√Hz
Channel Separation			-108			-108		dB
The following specifications apply for -55°C ≤ T_A ≤ +125°C for HA-4741-2, 0°C ≤ T_A ≤ +70°C for HA-4741-5.								
Input Offset Voltage	$R_S \leq 10$ KΩ		4.0	5.0		5.0	6.5	mV
Input Offset Current				75			100	nA
Input Bias Current				325			400	nA
Large Signal Voltage Gain	$R_L \geq 2$ KΩ V_{OUT} ±10V	25,000			15,000			V/V
Output Voltage Swing	$R_L \geq 10$ KΩ	±12	±13.7		±12	±13.7		V
	$R_L \geq 2$ KΩ	±10	±12.5		±10	±12.5		V
Supply Current (all Amplifiers)			10			10		mA
Average Offset Voltage Drift			5			5		μV/°C
Common Mode Rejection Ratio	$R_S \leq 10$ KΩ ΔV ±5V	74			74			dB
Power Supply Rejection Ratio	$R_S \leq 10$ KΩ ΔV ±5V	80			80			dB

Notes: 1. Rating applies for case temperature of +25°C maximum; derate linearity at 6.4 mW/°C for temperatures above +25°C.
2. For supply voltage less than ±15V, the absolute maximum input voltage is equal to the supply voltage.
3. Short circuit to ground on one amplifier only.

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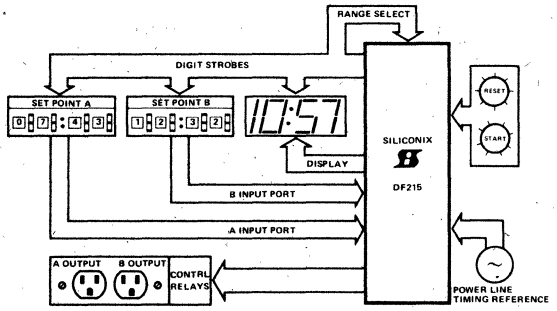
DF215 DUAL SET POINT TIMER/COUNTER

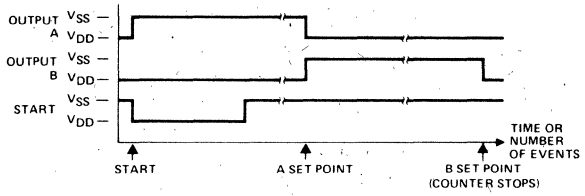
Features

- Two Timed Outputs for Versatile Equipment Control
- 0.1 Second Timing Interval Resolution
- Electrically Selectable Mode Control for Event Counting, 50 Hz Time Reference, or 60 Hz Time Reference
- Single or Continuous Cycle Operation
- 16 ms Accuracy
- Start Input Lock Out
- 4 Multiplexed Digits With Parallel Segment Outputs
- Single Unregulated Power Supply (8 to 20 Volts)
- Low Power (Typically 50 mW)
- Internal Oscillator for Logic Timing



Description

The DF215 is a P-channel, depletion load MOS device containing all the necessary logic to implement a single or dual set point timer or counter. The device typically uses one or two thumbwheel switch banks to provide two sequential, fully selectable, accurate intervals for equipment control. Figure 1 shows the control output response. The DF215 either counts events or time intervals using a 50 Hz or 60 Hz power line time base. Multiplexed outputs provide the total elapsed time (or number of events) from start for display. Please see subsequent pages for more detailed Applications information.



Timing Diagram
Figure 1

Applications

- Industrial Process Control
- Commercial Food Preparation Control
- Automatic Feed, Fluid, or Material Dispensing
- Step and Repeat Control

DF213 DF214 DIGITAL STOPWATCH

Features

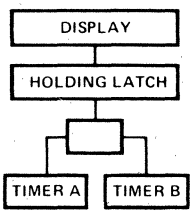
- Two Independent Timing Functions
- Remote Control for Precision Timing
- On Chip Amplifier for 3.2768 MHz Crystal Oscillator
- Multiplexed BCD Display Outputs
- Selectable Digit Strobe Duty Cycle for Low or High Ambient Light Conditions
- Leading Zero Suppression
- Provision for Low Battery Indication
- Electronic Interlock Prevents Accidental Reset
- Selectable Round-up or Round-off for Five Digit Display
- Maximum Count to Zero Rollover
  - DF213 59:59.99 to 00:00.0
  - DF214 99.999 Minutes to 00.000 Minutes

Applications

- Sports Timing – Auto Racing, Track, Swimming, Rodeo, Sailing, Football, Soccer
- Industrial Timing – Testing, Time-Motion Studies, Process Timing
- Scientific Timing – Chemical Reaction Timing, Mechanical Stress Timing, Animal Behavior Studies

Description

The DF213 and DF214 are P-Channel MOS devices containing all the necessary logic to implement several configurations of a digital stopwatch. A 3.2768 MHz crystal oscillator provides an extremely accurate time reference. Each device contains two timers that operate independently.



The holding latch is updated continuously from timer A or timer B or it can "freeze" the display time at a touch of a button. This configuration allows versatile event timing with "split" capability normally requiring skilled manipulation of two stopwatches. The DF213 times in minutes, seconds, and hundredths of a second providing up to six digits of display. The DF214 times in minutes and thousandths of a minute providing five digits of display.

DF211 CMOS WATCH CHIP

Features

- Multiplexed 4 digit, 7 segment LED watch chip.
- Days, hours, minutes, seconds.
- Days, hours, or minutes can be set independently; seconds can be synchronized to another time source.
- Operation from 2.7 to 3.4 volts (two silver-oxide batteries). Functionality down to 2.1 V typical.
- Provision for low battery indication.
- Debounce circuitry provided on all switch inputs.
- 12 or 24 hour display option, with "AM" indication on the 12 hour option.
- Selectable digit strobe duty cycle for high and low ambient light conditions.

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DF215 DUAL SET POINT TIMER/COUNTER

ELECTRICAL CHARACTERISTICS

All voltages referenced to V_{DD} (pin 28).

		CHARACTERISTIC		MIN	TYP*	MAX	UNITS	TEST CONDITIONS UNLESS OTHERWISE NOTED: V_{SS} = 8 V, T_A = 25°C, F_{osc} = 40 kHz	
1	POWER	V_{SS}		8.0	10.0	20.0	V		
2	POWER	I_{SS}			4	7	mA	V_{SS} = 8 V	No Output Loads
						10		V_{SS} = 20 V	
3	OUT	I_{OL}	(All Outputs)	12		60	µA	V_{OL} = 0.4 V	
4	OUT	I_{OH}	(All Outputs)	-2			mA	V_{OH} = 6.0 V	
5	INPUTS	I_{IH}			20		µA	V_{IH} = 8 V	
6	INPUTS	I_{IL}			-80			V_{IL} = 0 V	
7	INPUTS	V_{IH}		V_{SS} -1.5		V_{SS}	V		
8	INPUTS	V_{IL}		0		V_{SS} -6			
9	INPUTS	V_{IH}	Count Input (pin 21)			V_{SS}			
10	INPUTS	V_{IL}		V_{SS} -4					
11	INPUTS	I_{IH}		0.1		150	µA		
12	INPUTS	I_{IL}				-150			
13		F_{osc}			40		kHz		
14		Digit Strobe Duty Cycle			12.5		%		
15		Resolution			0.1		Sec	999.9 sec. Range	
16		Accuracy		-16		4	mS	Accuracy = Reading – Actual Time	
17		Count Input	Pulse Width	75			µS		
18		Count Input	Frequency	0		710	Hz		
19		Count Input	Frequency in Continuous Cycle Mode			60	Hz	50% Duty Cycle	

FUNCTIONAL DESCRIPTION

1.0 Set Point Inputs – The DF215 continually compares the number in the main counter to one of the two 4-digit numbers provided by external thumbwheel switches or fixed diode arrays. These 4-digit numbers are designated set points A and B. Two 4-bit wide BCD input ports are used to read set points A and B in a bit parallel, digit serial fashion. The least significant digit is entered first during the D_1 strobe time. Digit two, digit three, and digit four (MSD) are entered during the strobe times of D_2, D_3 and D_4 respectively. This is easily implemented by strobing the thumbwheel switches with the digit strobe outputs. Each port input has an internal pull-down resistor to V_{DD}

2.0 Control Outputs – Dual Set Point Operation – There are two control outputs, designated output A and output B. Both outputs are low (V_{DD}) when the main counter is reset. Output A goes high (to V_{SS}) at start and remains high during the first interval. Output A goes low and output B goes high when the A set-point compares with the main counter to start the second interval. Output B goes low and the counter stops when the B set point compares with the main counter.

2.1 Control Output – Single Set Point Operation – The DF215 will operate as a single set point timer by connecting the single thumbwheel switch bank to the B input port. The A port is not connected. In this mode output B goes high at start and remains high during the timed interval. Output B goes low and the counter stops when the time register compares with the set point.

3.0 Start Input (pin 25) – The first V_{SS} to V_{DD} transition of the Start input resets and starts the main counter. Subsequent transitions are ignored until 1.5 mS before the end of the second interval. The Start input must then be at V_{SS} for 50 µs before the next start transition is recognized.

4.0 Count Input (pin 21) – Connect this input to the AC line, power transformer secondary, or an event counting transducer through a protection resistor (see Figure 8). The count input impedance is very high near the switching point. Internal clamping circuitry prevents the pin voltage from exceeding the supply voltage.

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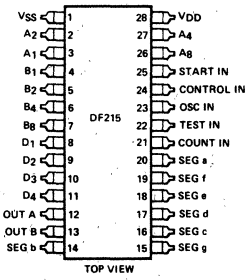
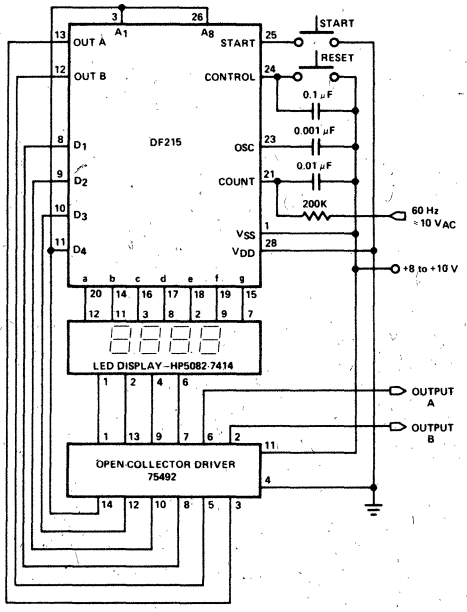
DF215 DUAL SET POINT TIMER/COUNTER

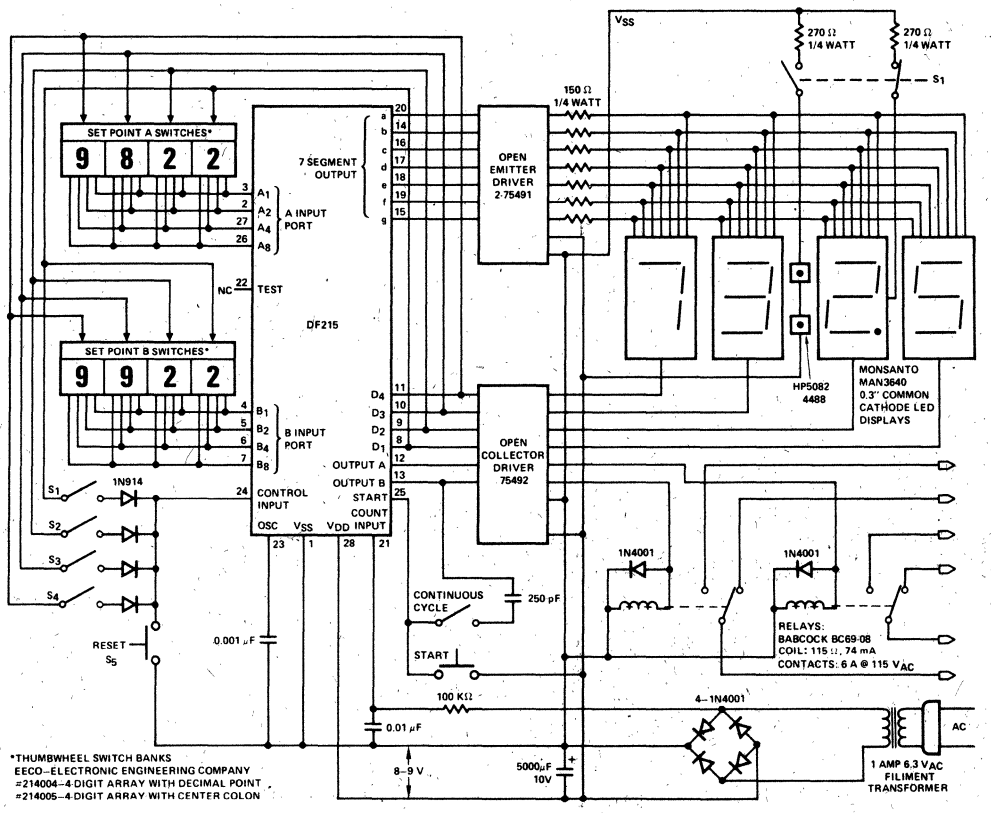
APPLICATIONS



Order Number
DF215CJ



900 Second Timer Small, LED Display Interface



Interval Timer — Typical Dual Set Point Application

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L144 LOW-POWER TRIPLE OPERATIONAL AMPLIFIER

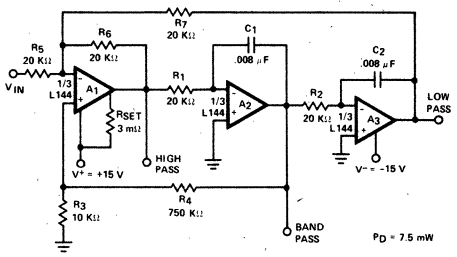
Description

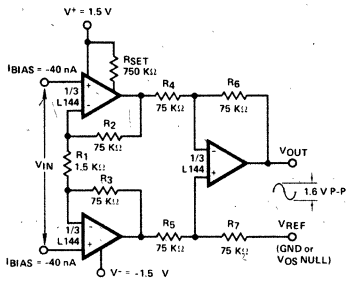
The L144 is a monolithic low-power triple operational amplifier stabilized for all feedback configurations and capacitive loads by internal gain compensation. Low power requirements permit high voltage operation across the rated temperature range, as well as battery operation from ±1.5 V.

Features

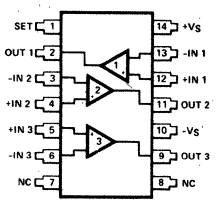
- **External Control of Supply Current and Output Drive**
- **Operation with ± 1.5 V to ± 15 V Power Supplies**
- **80 dB Gain with 20K Ω load**
- **± 30 V Differential Input Voltage Range**
- **Drives Large Capacitive Loads (>1000 pF)**
- **Internally-Compensated**
- **Continuous Short-Circuit Protection**
- **Monolithic Construction**
- **Slew Rate 0.4 V/μs Typical**

Active Filter





Instrumentation Amplifier



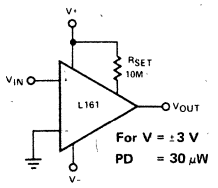
L161 15 μW MICROPOWER QUAD COMPARATOR

Description

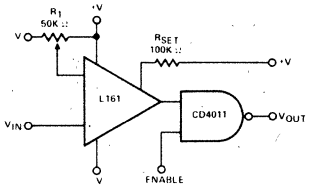
The L161 is a monolithic quad micropower comparator circuit, with an external control for varying supply current, input bias current and output current drive. This is accomplished by a single resistor connected to V+ which controls the bias current to a series of current mirrors which supply bias to a differential amplifier. The L161 finds applications in areas where low powered battery operation and CMOS compatibility are required. The ability to control comparator characteristics makes this a very versatile device.

Features

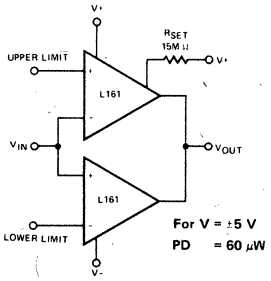
- Power Dissipation as Low as 15 μW
- External Control of Supply Current and Output Drive
- Operation with ±1.5 V to ±18 V Power Supplies
- Single Supply Operation
- Gain Greater than 20K
- Sensing Near Ground
- ±36 V Differential Input Voltage Range
- Slew Rate 3 V/μs Typical
- CMOS Logic Compatible
- Operation in Low and High Power Modes



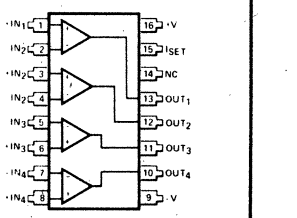
Double Ended Limit Detector



CMOS Line Receiver



Zero Crossing Detector



LM3909 MICROPOWER LED FLASHER

Description

The LM3909 is a monolithic oscillator specifically designed to flash Light Emitting Diodes. By using the timing capacitor for voltage boost, it delivers pulses of two or more volts to the LED while operating on a supply of 1.5 V or less. The circuit is inherently self-starting, and requires addition of only a battery and a capacitor to function as an LED flasher.

Features

- **Operation Over One Year From One C Size Flashlight Cell**
- **Bright, High Current LED Pulse**
- **Minimum External Parts**
- **Low Cost**
- **Low Voltage Operation, From Just Over 1 V to 5 V**
- **Low Current Drain, Averages Under 0.5 mA During Battery Life**
- **Powerful; As An Oscillator Directly Drives An 8 Ω Speaker**
- **Wide Temperature Range**

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INTRODUCTION TO MEMORY

MEMORY.....

The Master Selection Guide provides sufficient information to make initial product selections, to lead you to a group of device numbers and manufacturers' names. It enables you to find the products which are most appropriate to fulfill your major requirements and then provides data for many of the more important products.

All devices that appear in this section, both in the initial selection guide and in the data pages, are included in the Part Number and Product Indexes. These index listings lead to the page and the line on that page where each device appears.

The Memory Section provides initial selection information and data on PROMs, RAMs, and ROMs as well as other memory devices. In these particular sections, the devices are characterized by organization (words and bits/word) and by access times. In order to assure that the access times are comparable, whenever possible the values have been shown in nanoseconds over the full rated temperature range for the devices (i.e., 0° to 70°C for commercial units and −55°C to 125°C for military units). The full temperature nanosecond value is marked "nsF." When this value isn't specified, the guaranteed nanosecond value at room temperature is listed followed by "nsR." In some cases a guaranteed value has not yet been established; then the typical value is shown followed by "ns." "Typical" values are invariably much faster than the guaranteed ones so that such listings place these memories higher on the list than they otherwise would appear.

Category	Page
Character Generators	606
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ROMs	
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American Microsystems Inc.	634
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Harris Semiconductor	675
Intel	683
National Semiconductor	986
Texas Instruments	1090

The manufacturers listed above are providing detailed information on their latest and most significant products. They have made this investment to help you. Some chose not to.

If you want to see more data in future editions, tell the manufacturers through their salesmen and distributors.

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MEMORY—Character Generators

Format	Number of Output Lines	Input Logic levels	Supply Voltage	Device	Source
Character Generators					
4 x 5	25	MOS	-12,14	4881	Nortec
5 x 5	25	MOS	-12,14	4881	Nortec
6 x 8	8	TTL	-12,5	MM4241	† National
			-12,5	MM5241	National
5 x 7	1	TTL	5	DM8678	National
	5	MOS	±12	4481	Nortec
		TTL	5	RO3-2513	EMM/Semi
			5	6061	MMI
			5	6055	MMI
			-12,±5	2513	Signetics
			-12,5	3258	Fairchild
			-12,5	35581	Fairchild
			-12,5	35582	Fairchild
			5	RO3-2513	GI
			-12,5	TMS2501	TI
	7	MOS	±12	MCS1004	MOS
			±12	MCS1005	MOS
			±14	CG4100	SMC
			±14	TMS4103	TI
			-14,-28	MK2002	Mostek
		TTL	±12	EA40105	EA
			-12,5	3257	Fairchild
			-12,5	RO5-2240S	GI
			-12,5	MK2302	Mostek
			-12,±5	2516	Signetics
	8	TTL	-12,±5	2516	Signetics
	10	TTL	-12,5	MK2408	Mostek
5 x 8	5	MOS	±12	MM4240	† National
7 x 8	4	TTL	5	N8228CB	Signetics
	10	MOS	±12	EA4004	EA
	35	MOS	-12,14	4881	Nortec
7 x 9	1	TTL	5	DM7678	† National
			5	DM7679	† National
			5	**DM8678**	**National (724)**
			5	DM8679	National
			-12,5	MM4220	† National
			-12,5	MM5220	National
	7	MOS	±5	MCS2017	MOS
		TTL	-12,5	**S8564**	**AMI (634)**
			-12,5	3260	Fairchild
			5	5290	† MMI
			5	6071	MMI
			5	6072	MMI
			5	6290	MMI
			±5	MCS2022	MOS
			5	MCM6571	Motorola
			-3,5,12	MCM6570	Motorola
			-3,5,12	MCM6571A	Motorola
			-3,5,12	MCM6572	Motorola
			-3,5,12	MCM6573	Motorola
			-3,5,12	MCM6574	Motorola
			-3,5,12	MCM6575	Motorola
			-3,5,12	MCM6576	Motorola
			-3,5,12	MCM6577	Motorola
			-3,5,12	MCM6578	Motorola
			-3,5,12	MCM6579	Motorola
			-3,5,12	NC6570	Nitron
			±5,2	NC6570A	Nitron
			-3,5,12	NC6571	Nitron
			-3,5,12 (Cont'd)	NC6571	Nitron

Format	Number of Output Lines	Input Logic levels	Supply Voltage	Device	Source
Character Generators (Cont'd)					
7 x 9	7	TTL		(Cont'd)	
			-3,5,12	NC6571A	Nitron
			-3,5,12	NC6572	Nitron
			-3,5,12	NC6573	Nitron
			-3,5,12	NC6574	Nitron
			-3,5,12	NC6575	Nitron
			-3,5,12	NC6576	Nitron
			-3,5,12	NC6580	Nitron
			-3,5,12	NC6581	Nitron
			-3,5,12	NC6583	Nitron
			5	2609	Signetics
	9	MOS	-12,-24	EA3815	EA
			±12	EA4001	EA
		MOS/TTL	±5	MCS2024	MOS
		TTL	5	6074	MMI
			5	6073	MMI
			-3,5,12	MCM6580	Motorola
			-3,5,12	MCM6581	Motorola
			-3,5,12	MCM6583	Motorola
			-3,5,12	NC6580	Nitron
			-3,5,12	NC6581	Nitron
			-3,5,12	NC6583	Nitron
7 x 10	7	MOS/TTL	±5	MCS2020	MOS
		TTL	±12	EA4016	EA
7 x 11	1	TTL	5	CG5004L	SMC
9 x 9	9	TTL	-12,5	RO5-5184	GI
			5	5292	† MMI
			5	6292	MMI
10 x 12	10	MOS/TTL	±5	MCS2018	MOS
			±5	MCS2025	MOS

† Military Temperature Range (−55°C to 125°C) * Typical Values

Bold face indicates additional data is provided on the page noted.

MEMORY—Code Converters

Code Conversion From	To	Bits In	Bits Out	Process	Supply Voltage	Device	Source
Code Converters							
ASCII-BCDIC		6	6	PMOS	±12	MM4220LR	† National
					±12	MM5220LR	National
ASCII-EBCDIC		6	7	PMOS	±12	MM4220EK	† National
					±12	MM5220EK	National
		7	8	PMOS	±12	MM4220AE	† National
					±12	MM5220AE	National
					-12,5	MM4221RR	† National
					-12,5	MM5221RR	National
		8	8	PMOS	-12,5	MK2503	Mostek
					-12,5	MK2601	Mostek
					±12	MM4230QY	† National
					±12	MM5230QY	National
			10	PMOS	±12	EA4015	EA
ASCII-HOLLERITH		8	8	PMOS	±12	MM4231BUS	National
					±12	MM5231BUS	National
		9	10	PMOS	-24	EA4035	EA
ASCII-RS244A and Vice Versa		6	8	PMOS	-12,5	MM4221RQ	† National
					-12,5	MM5221RQ	National
ASCII-SELECTRIC		7	7	PMOS	-12,5	3512A	Fairchild
					±12	MM4230KP	† National
					±12	MM5230KP	National
BCD-BINARY		6	6	Bipolar	5	SN54184	† TI
					5	SN74184	TI
BCDIC-ASCII		6	7	PMOS	±12	MM4220AP	† National
					±12	MM5220AP	National
					±12	MM4220LR	† National
					±12	MM5220LR	National
BCDIC-EBCDIC		6	7	PMOS	±12	MM4220EK	† National
					±12	MM4230JT	† National
					±12	MM5220EK	National
					±12	MM5230JT	National
Baudot-ASCII		5	8	PMOS	±12	MM4220BL	† National
					±12	MM5220BL	National
BINARY-BCD		6	6	Bipolar	5	SN54185A	† TI
					5	SN74185A	TI
		8	9	Bipolar	5	MCM4067A	Motorola
					5	MCM4068A	Motorola
EBCDIC-ASCII			8	Bipolar	5	N8204	Signetics
				PMOS	-12,5	MK2503	Mostek
					-12,5	MK2601	Mostek
					±12	MM4230QX	† National
					±12	MM4231RP	† National
					±12	MM5230QX	National
					±12	MM5231RP	National
					-12,5	N2461	Signetics
			10	PMOS	±12	EA4015	EA
		9	8	PMOS	±12	N2430	Signetics
		12	8	Bipolar	5	DM8576AAA	National
EBCDIC-DCDIC		7	6	PMOS	±12	MM4230JT	† National
					±12	MM5230JT	National
EBCDIC-HOLLERITH		9	10	MOS	-24	EA4034	EA
			10	PMOS	-24	EA4035	EA
		12	8	Bipolar	5	MCM4069A	Motorola
					(Cont'd)		
EBCDIC-HOLLERITH					5	MCM4070A	Motorola
EBCDIC-SELECTRIC		8	8	PMOS	±12	MM4230FE	† National
					±12	MM5230FE	National
HOLLERITH-ASCII		8	8	PMOS	±12	MM4230BO	† National
					±12	MM5230BO	National
					±12	MM4231BUS	† National
					±12	MM5231BUS	† National
HOLLERITH-EBCDIC		8	8	PMOS	±12	MM4230QW	† National
					±12	MM5230QW	National
		9	10	PMOS	-24	EA4034	EA
Multiple SELECTRIC, HOLLERITH-EBCDIC-ASCII and Vice Versa				NMOS	-3,5,12	MCM6561	Motorola
					-3,5,12	MCM6562	Motorola
					-3,5,12	NC6561	Nitron
Multiple ASCII-SELECTRIC, EBCDIC, HOLLERITH				NMOS	-3,5,12	MCM6591	Motorola
						NC6591	Nitron
SELECTRIC-EBCDIC		8	8	PMOS	±12	MM4230FE	† National
					±12	MM5230FE	National

† Military Temperature Range (−55°C to 125°C) * Typical Values

MEMORY—EAROMs, FIFOs, LIFOs, PLAs

Electrically Alterable ROMs

Words	Bits Per Word	Access Time (Max)	Output	Supply Voltage	Device	Source
1	1			±20	NOM201	Plessey
	2			±20	NOM202	Plessey
	4			±20	NOM204	Plessey
8	8			20	NOM401	Plessey
32	16	10 μsF		-28,5	ER2050	GI
64	4	1.0 μsF		-15	TMM141-1	Toshiba
		1.5 μsF		-15	TMM141-1	Toshiba
				-15	TMM141	Toshiba
		2 μsF		±15,5	NC7040	Nitron
100		3.4 msF		-35	ER1400	GI
256	4	1 μsF		±15,5	NC7050	Nitron
		1.5 μsF		-15	TMM142	Toshiba
		2 μsF		±12	ER1105	GI
				±12	1105	NCR
	8	800 nsF	TS	5,12	μPD454	NEC
	9	1 μsF	TS	-30,-12	MN1102	Panasonic
512	2	25 μsR		-30	NC7010	Nitron
1024	1	5 μsF	TS	-30	NC7051	Nitron
		25 μsR	TS	-30	NC7010	Nitron
			TS	-30	2400	NCR
	4	600 nsF	TS	-30,-12,5	ER3400	GI
		2 μsF	TS	-23,-14,±5	ER2401	GI
	8	450 nsF	TS	5,12	μPD458	NEC
2048	4	2 μsF	TS	-30,12,5	ER2800	GI

First-In First-Out

Words	Bits / Word	Data Rate MHz (max)	Supply Voltage	Device	Source
16	2	10*	5	8X04	Signetics
			13	8X03	Signetics
	4	8.0*	3-15	CD40105B	† RCA
		8.0*	3-15	CD4015BE	RCA
		10.0	5	9403C	Fairchild
		10.0	5	9403M	† Fairchild
	5	20.0	5	SN74S225	TI
24	4	2.5	5-16	MS618	† Ragen
32	8	0.25	-12,5	MP3812A	† Plessey
		0.25	-12,5	MP3812B	Plessey
		0.5	-12,5	AM2812C	AMD
		0.5	-12,5	AM2812M	† AMD
		1.0	-12,5	AM2812AC	AMD
		1.0	-12,5	AM2812AM	† AMD
	9	0.25	-12,5	MP3813	Plessey
		0.25	-12,5	MP3813A	† Plessey
		0.5	-12,5	AM2813C	AMD
		0.5	-12,5	AM2813M	† AMD
		1.0	-12,5	AM2813AC	AMD
		1.0	-12,5	AM2813AM	† AMD
40	9	0.25	-12,5	FR1502E-02	Western
		0.5	-12,5	FR1502E-01	Western
		1.0	-12,5 (Cont'd)	33522	Fairchild

First-In First-Out (Cont'd)

Words	Bits / Word	Data Rate MHz (max)	Supply Voltage	Device	Source
40	9	1.0		(Cont'd)	
		1.0	-12,5	FR1502E	Western
		1.0	5	COM5014	SMC
		2.0	-12,5	33511	Fairchild
64	4	0.7	-12,5	3341C	AMD
			-12,5	3341	Fairchild
		1.0	-12,5	AM2841C	AMD
		1.0	-12,5	AM2841M	† AMD
		1.0	-12,5	3341A	Fairchild
		2.0	-12,5	ITT3341	ITT
		2.0	-12,5	ITT3342	ITT
		5.0	5	9423	Fairchild
		10.0	5	57401	† MMI
		10.0	5	67401	MMI
	9	0.25	-12,5	TMS4024	TI

Last-In First-Out

Words	Bits / Word	Data Rate MHz (max)	Supply Voltage	Device	Source
16	4		5	9406C	Fairchild
				9406M	Fairchild

PLA's

Organization	Propagation Time	Output	Supply Voltage	Device	Source
48 Product Terms, 16 Inputs, Field Programmable	50 nsF	OC	5	93458	Fairchild
		TS	5	93459	Fairchild
		OC	5	N82S101	Signetics
		TS	5	N82S100	Signetics
	80 nsF	OC	5	S82S101	Signetics
		TS	5	S82S102	Signetics
48 Product Terms, 14 Inputs, Factory Programmable	50 nsF	OC	5	N82S201	Signetics
		TS	5	N8S200	Signetics
48 Product Terms, 14 Inputs, Field Programmable	60 nsF	OC	5	HM7660-5	Harris
			5	HM7661-5	Harris
	85 nsF	OC	5	HM7660-2	† Harris
			5	HM7661-2	† Harris
	100 nsF		5	IM5200	Intersil
50 Product Terms, 12 Inputs, 60 Outputs Field Programmable	35 ns	TS	5	**SN54S330**	**† TI (1100)**
		TS	5	**SN74S330**	**TI (1100)**
			5	**SN54S331**	**† TI (1101)**
			5	**SN74S331**	**TI (1101)**
70 Product Terms, 19 Inputs, Factory Programmable	660 nsF		5 (Cont'd)	HPLA0174	Hughes

† Military Temperature Range (−55°C to 125°C) * Typical Values nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

Bold face indicates additional data is provided on the page noted.

MEMORY—EAROMs, FIFOs, LIFOs, PLAs (Cont'd)

	Organization	Propagation Time	Output	Supply Voltage	Device	Source
	PLA's (Cont'd)					
	70 Product Terms, 19 Inputs, Factory Programmable				(Cont'd)	
		150 nsF		5	**DM7575**	† **National (739)**
				5	**DM7576**	† **National (739)**
				5	**DM8575**	**National (739)**
				5	**DM8576**	**National (739)**
10	158 NAND Gates	—		5	CGA	TRW

Organization	Propagation Time	Output	Supply Voltage	Device	Source
PLA's					

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

MEMORY—PROMs

PROMs

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
32 x 8	ECL		OE	-5.2	MC10139	† Motorola
		20 nsR	OE	-5.2	10139	Signetics
	TTL	30 nsF	OC	5	**DM74S188**	**National (706)**
			TS	5	**DM74S288**	**National (706)**
		40 nsF	OC	5	AM29750C	AMD
			TS	5	AM29751C	AMD
			OC	5	MB7056	Fujitsu
			TS	5	MB7051	Fujitsu
			OC	5	**HM7602-5**	**Harris (682)**
			TS	5	**HM7603-5**	**Harris (682)**
			OC	5	**DM54S188**	**† National (706)**
			TS	5	**DM54S288**	**† National (706)**
			OC	5	**SN74S188**	**TI (860)**
			TS	5	SN74S288	TI
		50 nsF	OC	5	**HM7602-2**	**† Harris (682)**
			TS	5	**HM7603-2**	**† Harris (682)**
			OC	5	6330-1	MMI
			TS	5	6331-1	MMI
			OC	5	N82S23	Signetics
			TS	5	N82S123	Signetics
			OC	5	**SN54S188**	**† TI (860)**
			TS	5	SN54S288	† TI
		50 nsR	OC	5	HPROM8256-2	† Harris
			OC	5	HPROM8256-5	Harris
			OC	5	IM5600C	Intersil
			OC	5	IM5600M	† Intersil
			TS	5	IM5610C	Intersil
			TS	5	IM5610M	† Intersil
			OC	5	**DM8577**	**National (702)**
			TS	5	**DM8578**	**National (702)**
			OC	5	SN54188A	† TI
			OC	5	SN74188A	TI
		55 nsF	OC	5	AM27LS08C	AMD
			TS	5	AM27LS09C	AMD
		60 nsF	OC	5	5330-1	† MMI
			TS	5	5331-1	† MMI
		65 nsF	OC	5	AM29750M	† AMD
			TS	5	AM29751M	† AMD
			OC	5	S82S23	† Signetics
			TS	5	S82S123	† Signetics
		70 nsF	OC	5	**DM7577**	**† National (702)**
			TS	5	**DM7578**	**† National (702)**
		70 nsR	OC	5	IM5600CF	Intersil
			TS	5	IM5610CF	Intersil
		75 nsF	OC	5	AM27LS08M	† AMD
			TS	5	AM27LS09M	† AMD
64 x 8	TTL	75 nsR	OC	5	JAN38510/201	† Harris
			OC	5	HPROM0512-2	† Harris
			OC	5	HPROM0512-5	Harris

(Cont'd)

PROMs (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
64 x 8	TTL	75 nsR			(Cont'd)	
			OC	5	MCM5003A	Motorola
			—	5	MCM5004A	Motorola
			OC	5	MCM5303A	† Motorola
			—	5	MCM5304A	† Motorola
			OC	5	SN54186	† TI
			OC	5	SN74186	TI
256 x 4	CMOS	300 nsF		5	**HM6610**	**† Harris (680)**
			TS	5	**HM6611**	**† Harris (680)**
			TS	5	HM6612	† Harris
		500 nsF		5	**HM6610D**	**Harris (680)**
			TS	5	**HM6611D**	**Harris (680)**
			TS	5	HM6612D	Harris
	ECL	12 ns	OE	-5,2	GXB1049	Siemens
		15 ns	OE	-5.2	F10416C	Fairchild
		20 nsF	OE	-5.2	10149	Signetics
		25 nsF	OE	-5.2	HM7615-5	Harris
		25 nsR	OE	-5.2	MCM10149	Motorola
		30 nsF	OE	-5.2	10149	MMI
	TTL	40 nsF	OC	5	MB7052	Fujitsu
			TS	5	MB7057	Fujitsu
			OC	5	HM7610A-5	Harris
			TS	5	**HM7611A-5**	**Harris (682)**
			OC	5	N82S27	Signetics
		45 nsF	OC	5	93417C	Fairchild
			TS	5	93427C	Fairchild
		50 nsF	OC	5	**3601-1**	**Intel (695)**
			TS	5	**3621-1**	**Intel (695)**
			OC	5	**DM74S387**	**National (708)**
			TS	5	**DM74S287**	**National (708)**
			OC	5	N82S126	Signetics
			TS	5	N82S129	Signetics
		55 nsF	OC	5	6300-1	MMI
			TS	5	6301-1	MMI
		60 nsF	OC	5	93417M	† Fairchild
			TS	5	93427M	† Fairchild
			OC	5	**HM7610-5**	**Harris (682)**
			TS	5	**HM7611-5**	**Harris (682)**
			OC	5	**DM54S387**	**† National (708)**
			TS	5	**DM54S287**	**† National (708)**
		60 nsR	OC	5	AM27LS10C	AMD
			OC	5	AM27LS10M	† AMD
			TS	5	AM27LS11C	AMD
			TS	5	AM27LS11M	† AMD
			OC	5	IM5603AC	Intersil
			OC	5	IM5603AM	† Intersil
			TS	5	IM5623C	Intersil
			TS	5	IM5623M	† Intersil
			OC	5	μPB403	NEC
		65 nsF	OC	5	**SN74S387**	**TI (861)**

(Cont'd)

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

Bold face indicates additional data is provided on the page noted.

MEMORY—PROMs (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
PROMs (Cont'd)						
256 x 4	TTL	65 nsF			(Cont'd)	
			TS	5	**SN74S287**	**TI (861)**
		70 nsF	OC	5	AM27LS10C	AMD
			TS	5	AM27LS11C	AMD
			OC	5	AM29760C	AMD
			TS	5	AM29761C	AMD
			OC	5	**3601**	**Intel (695)**
			TS	5	**3621**	**Intel (695)**
			OC	5	R29660	Raytheon
			TS	5	R29661	Raytheon
			OC	5	S82S126	† Signetics
			TS	5	S82S129	† Signetics
		70 nsR	OC	5	HPROM1024A-2	† Harris
			OC	5	HPROM1024A-5	Harris
			TS	5	HPROM1024-2	† Harris
			TS	5	HPROM1024-5	Harris
		75 nsF	OC	5	**HM7610-2**	**Harris (682)**
			TS	5	**HM7611-2**	**† Harris (682)**
			OC	5	5300-1	† MMI
			TS	5	5301-1	† MMI
			OC	5	**SN54S387**	**† TI (861)**
			TS	5	**SN54S287**	**† TI (861)**
		80 nsF	OC	5	AM27LS10M	† AMD
			TS	5	AM27LS11M	† AMD
		90 nsF	OC	5	M3601	† Intel
256 x 8	TTL	60 nsF	OC	5	**DM87S221**	**National (720)**
			TS	5	**DM87S222**	**National (720)**
			OC	5	**DM74S470**	**National (718)**
			TS	5	**DM74S471**	**National (718)**
			TS	5	N82S114	Signetics
		65 nsF	OC	5	6308-1	MMI
			TS	5	6309-1	MMI
		70 nsF	OC	5	**SN74S470**	**TI (862)**
			TS	5	**SN74S471**	**TI (862)**
		75 nsF	OC	5	**DM77S221**	**† National (720)**
			TS	5	**DM77S222**	**† National (720)**
			OC	5	**DM54S470**	**† National (718)**
			TS	5	**DM54S471**	**† National (718)**
		80 nsF	OC	5	**SN54S470**	**† TI (862)**
			TS	5	**SN54S471**	**† TI (862)**
		85 nsF	OC	5	5308-1	† MMI
			TS	5	5309-1	† MMI
		90 nsF	OC	5	6340-1	MMI
			TS	5	6341-1	MMI
			TS	5	S82S114	† Signetics
		100 nsF	OC	5	5340-1	† MMI
			TS	5	5341-1	† MMI

(Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
PROMs (Cont'd)						
256 x 8					(Cont'd)	
	PMOS-E Erasable	550 nsF	TS	-9,5	MK3702-1	Mostek
		650 nsF	TS	-9,5	1702A-2	Intel
			TS	-9,5	1702A-2	Signetics
		750 nsF	TS	-9,5	9702-1	AMD
			TS	-9,5	MK3702-2	Mostek
			TS	-9,5	MM1702AQ-1	National
		1 μsF	TS	-9,5	1702A	AMD
			TS	-9,5	1702A	Intel
			TS	-9,5	MK3702-3	Mostek
			TS	-9,5	**MM1702AQ**	**National (818)**
			TS	-9,5	1702A	Signetics
			TS	-9,5	1700AL	Signetics
			TS	-12,5	MM4203Q	National
			TS	-12,5	MM5203Q	National
		1.3 μsF	TS	-9,5	8702A	AMD
			TS	-9,5	8702A	Intel
			TS	-9,5	MM8702A	National
		1.5 μsF	TS	-9,5	1702A-6	AMD
			TS	-9,5	1702A-6	Intel
			TS	-9,5	MM1702AQ-6	National
			TS	-9,5	1702A-6	Signetics
		1.7 μsF	TS	-10,5	4702A	AMD
			TS	-10,5	4702A	Intel
			TS	-10,5	MM4702A	National
		2.3 μsF	TS	-9,5	MM8702A-4	National
	PMOS	750 nsF	TS	-9,5	MM1702AD-1	National
		1 μsF	TS	-9,5	MK3602	Mostek
			TS	-9,5	**MM1702AD**	**National (818)**
			TS	-12,5	MM4203D	National
			TS	-12,5	MM5203D	National
512 x 4	TTL	50 nsF	OC	5	93436C	Fairchild
			TS	5	93446C	Fairchild
			OC	5	**HM7620A-5**	**Harris (682)**
			TS	5	HM7621A-5	Harris
			OC	5	N82S130	Signetics
			TS	5	N82S131	Signetics
		55 μsF	OC	5	**DM74S570**	**National (710)**
			TS	5	**DM74S571**	**National (710)**
		60 nsF	OC	5	93436M	† Fairchild
			TS	5	93446M	† Fairchild
			OC	5	6305-1	MMI
			TS	5	6306-1	MMI
		70 nsF	OC	5	**HM7620-5**	**Harris (682)**
			TS	5	**HM7621-5**	**Harris (682)**
			OC	5	**3602**	**Intel (697)**
			TS	5	**3622**	**Intel (697)**
			OC	5	**DM54S570**	**† National (710)**
			TS	5	**DM54S271**	**† National (731)**
			OC	5	S82S130	† Signetics
			TS	5	S82S131	† Signetics
		70 nsR	OC	5	IM5604C	Intersil
			OC	5	IM5604M	† Intersil

(Cont'd)

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

MEMORY—PROMs (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
PROMs (Cont'd)						
512 x 4	TTL	70 nsR			(Cont'd)	
			TS	5	IM5624C	Intersil
			TS	5	IM5624M	† Intersil
		75 nsF	OC	5	5305-1	† MMI
			TS	5	5306-1	† MMI
		85 nsF	OC	5	**HM7620-2**	† **Harris (682)**
			TS	5	**HM7621-2**	† **Harris (682)**
		90 nsF	OC	5	**3602-4**	**Intel (697)**
			TS	5	**3622-4**	**Intel (697)**
		120 nsF	OC	5	**3602L-6**	**Intel (697)**
			TS	5	**3622L-6**	**Intel (697)**
	PMOS-E Erasable	1 μsR	TS	-12,5	MM4203Q	National
			TS	-12,5	MM5203Q	National
			TS	-9,±5	T3181A	Toshiba
		1.5 μsR	TS	-9,±5	T3181B	Toshiba
	PMOS	1 μsF	TS	±5	TMM121-1	Toshiba
			TS	-12,5	MM4203D	National
			TS	-12,5	MM5203D	National
		1.5 μsF	TS	5	TMM121	Toshiba
512 x 8	TTL	55 nsF	OC	5	93438C	Fairchild
			TS	5	93448C	Fairchild
			OC	5	**SN54S473**	† **TI (863)**
			OC	5	**SN74S473**	**TI (863)**
			TS	5	**SN54S472**	† **TI (863)**
			TS	5	**SN74S472**	**TI (863)**
			OC	5	**SN54S475**	† **TI (864)**
			OC	5	**SN74S475**	**TI (864)**
			TS	5	**SN54S474**	† **TI (864)**
			TS	5	**SN74S474**	**TI (864)**
		60 nsF	TS	5	N82S115	Signetics
		65 nsF	OC	5	62485-1	MMI
			TS	5	62495-1	MMI
			OC	5	**DM74S473**	**National (702,722)**
			TS	5	**DM74S472**	**National (702,722)**
			OC	5	**DM77S295**	**National (714)**
			TS	5	**DM77S296**	**National (714)**
		70 nsF	OC	5	93438M	† Fairchild
			TS	5	93448M	† Fairchild
			OC	5	**HM7640-5**	**Harris (682)**
			TS	5	**HM7641-5**	**Harris (682)**
			OC	5	3604	Intel
			TS	5	3624	Intel
			OC	5	IM5605C	Intersil
			TS	5	IM5625C	Intersil
			OC	5	MCM7640	Motorola
			TS	5	MCM7641	Motorola
		80 nsF	OC	5	IM5605M	† Intersil
			TS	5	IM5625M	† Intersil
				(Cont'd)		

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
PROMs (Cont'd)						
512 x 8	TTL	80 nsF			(Cont'd)	
			OC	5	**DM54S473**	† **National (702,722)**
			TS	5	**DM54S472**	† **National (702,722)**
			OC	5	**DM87S295**	† **National (714)**
			TS	5	**DM87S296**	† **National (714)**
		85 nsF	OC	5	**HM7640-2**	† **Harris (682)**
			TS	5	**HM7641-2**	† **Harris (682)**
		85 nsF	OC	5	5248-1	† MMI
			TS	5	5249-1	† MMI
		90 nsF	OC	5	3604-4	Intel
			OC	5	M3604	† Intel
			OC	5	82S140	Signetics
			TS	5	82S141	Signetics
			TS	5	3624-4	Intel
			TS	5	M3624	† Intel
			TS	5	3604L-6	Intel
			TS	5	S82S115	† Signetics
			OC	5	6240-1	MMI
			TS	5	6241-1	MMI
		120 nsF	TS	5	3604L-6	Intel
			OC	5	5240-1	† MMI
			TS	5	5241-1	† MMI
	NMOS-E Erasable	450 nsF	TS	±5,12	2704	Intel
	PMOS-E Erasable	575 nsF	TS	-12,5	**S6834**	**AMI (889,661,930)**
		750 nsF	TS	-12,5	**S5204A**	**AMI (655,952)**
			TS		S6834-1	MMI
		1 μsF	TS	-12,5	**MM5204**	**National (824)**
		1.25 μsF	TS	-12,5	**MM4204**	**National (824)**
1024 x 4	TTL	55 nsF	OC	5	93452C	Fairchild
			TS	5	93453C	Fairchild
		60 nsF	OC	5	3605-2	Intel
			TS	5	3625-2	Intel
			OC	5	6350-1	MMI
			OC	5	6352-1	MMI
			TS	5	6351-1	MMI
			TS	5	6353-1	MMI
			OC	5	**DM74S572**	**National (702,712)**
			TS	5	**DM74S573**	**National (712)**
			OC	5	N82S136	Signetics
			TS	5	N82S137	Signetics
		70 nsF	OC	5	93452M	† Fairchild
			TS	5	93453M	† Fairchild
			OC	5	**HM7642-5**	**Harris (682)**
			TS	5	**HM7643-5**	**Harris (682)**
			—	5	**HM7644-5**	**Harris (682)**
			OC	5	**3605**	**Intel (699)**
				(Cont'd)		

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

Bold face indicates additional data is provided on the page noted.

MEMORY—PROMs (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
PROMs (Cont'd)						
1024 x 4	TTL	70 nsF			(Cont'd)	
			TS	5	**3625**	**Intel (699)**
			OC	5	MCM7642	Motorola
			TS	5	MCM7643	Motorola
		75 nsF	OC	5	5350-1	† MMI
			OC	5	5352-1	† MMI
			TS	5	5351-1	† MMI
			TS	5	5353-1	† MMI
			OC	5	**DM54S572**	**† National (702,712)**
			TS	5	**DM54S573**	**† National (702,702,712)**
		80 nsF	OC	5	μPB406	NEC
			TS	5	μPB426	NEC
		85 nsF	OC	5	**HM7642-2**	**† Harris (682)**
			TS	5	**HM7643-2**	**† Harris (682)**
			—	5	**HM7644-2**	**† Harris (682)**
		90 nsF	OC	5	S82S136	† Signetics
			TS	5	S82S137	† Signetics
1024 x 8	NMOS-E Erasable	450 nsF		±5,12	MB8515	Fujitsu
			TS	±5,12	2708	Intel
	TTL	70 nsF	OC	5	**DM87S229**	**National (716)**
			TS	5	**DM87S228**	**National (716)**
		90 nsF	OC	5	**DM77S229**	**† National (716)**
			TS	5	**DM77S228**	**† National (716)**
			OC	5	6280-1	MMI
			OC	5	6284-1	MMI
			OC	5	6286-1	MMI
			OC	5	N82S180	Signetics
			TS	5	6281-1	MMI
			TS	5	6285-1	MMI
			TS	5	6287-1	MMI
			TS	5	N82S181	Signetics
		120 nsF	OC	5	5280-1	† MMI
			OC	5	5284-1	† MMI
			OC	5	5286-1	† MMI
			TS	5	5281-1	† MMI
			TS	5	5258-1	† MMI
			TS	5	5287-1	† MMI
2048 x 4	TTL	100 nsF	OC	5	N82S184	Signetics
			TS	5	N82S185	Signetics
		150 nsF	OC	5	S82S184	† Signetics
			TS	5	S82S185	† Signetics

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
PROMs						

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

MEMORY—RAMs

Dynamic

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
1024 x x	NMOS	60 nsF		±15	EA1500A	EA
				-5,12	SY7103	Synertek
		120 nsF		±15	EA1500A-1	EA
	PMOS	100 nsF		19,22.5	SY1103A-X	Synertek
		110 nsF		19,22.5	1103A-X	Rockwell
		120 nsF		19,22.5	**S1103X**	**AMI (634)**
				19,22.5	ITT1103-X	ITT
		125 nsF		19,22.5	**S1103A-X**	**AMI (634)**
		145 nsF		19,22.5	**S1103A-1**	**AMI (634)**
				19,22.5	1103A-1	Intel
				19,22.5	1103A-2	Intel
				19,22.5	1103A-1	Rockwell
				19,22.5	1103A-2	Rockwell
				19,22.5	SY1103A-1	Synertek
		150 nsF		19,22.5	**S1103-1**	**AMI (634)**
				20,22.5,7	6002-11	Intersil
				19,22.5	HM3503-1	Hitachi
				19,22.5	1103-1	Intel
				19,22.5	ITT1103-1	ITT
				19,22.5	1103-1	Nortec
				20,22.5,7	6002	Nortec
				19,22.5	TMS1103-1	TI
				20,22,7	TMS4062	TI
				20,22,7	TMS4063	TI
				19,22.5	TMM211-1	Toshiba
		205 nsF		19,22.5	**S146**	**AMI (634)**
				16,19.5	**S1103A**	**AMI (634)**
				16,19.5	1103A	Intel
				19,22.5	ITT1103-146	ITT
				19,22.5	1103-146	Nortec
				16,22.5	1103A	Rockwell
				16,19.5	SY1103A	Synertek
		220 nsF		19,22.5	HM3503-2	Hitachi
		300 nsF		16,19.5	**S1103**	**AMI (634)**
				16,19.5	HM3503	Hitachi
				16,19.5	1103	Intel
				16,19.5	ITT1103	ITT
				16,19.5	1103	Nortec
				16,19.5	MM1003	Panasonic
				16,19.5	1103	Signetics
				16,19.5	TMS1103	TI
				16,19.5	TMM211	Toshiba
		400 nsF		-12,5	**S4006**	**AMI (634)**
				-12,5	MK4006	Mostek
		500 nsF		-12,5	**S4008**	**AMI (634)**
				-12,5	MK4008	Mostek
		800 nsF		-12,5	**S4008-9**	**AMI (634)**
2048 x 1	PMOS	350 nsF		-15,8,5	6003-11	Intersil
				-15,8,5	600311	Nortec
		460 nsF		-15,8,5,5	6003-10	Intersil
				-15,8.5,5	600314	Nortec
4096 x 1	I²L	100 nsF		5	93481C	Fairchild
	NMOS	100 nsF		-5.2,7,12	MB8215E	Fujitsu
		135 nsF	TS	±5,15	μPD411-4	NEC
		150 nsF	TS	±5,12	MB8107Y	Fujitsu
			TS	±5,12	FM4027-2	Fairchild
			TS	±5,12	IM7505A-1	Intersil
			TS	±5,12	7027-09	Intersil
			TS	-5,12	7270A-10	Intersil
				(Cont'd)		

Dynamic (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
4096 x 1	NMOS	150 nsF			(Cont'd)	
			TS	±5,12	7280A-10	Intersil
			TS	±5,12	MK4027-2	Mostek
			TS	±5,12	MCM6605A-1	Motorola
			TS	-5,12	**MM5270A**	**National (786)**
			TS	±5,12	**MM5280A**	**National (797)**
			TS	±5,12	μPD411-3	NEC
			TS	-5,12	μPD418-3	NEC
		170 nsF	TS	±5,12	RM1701H-17	Western
		200 nsF	TS	±5,12	7027-10	Intersil
			TS	±5,12	7280-11	Intersil
			TS	-5,12	7270-11	Intersil
			TS	-5,12	7271A-11	Intersil
			TS	±5,12	9060E	AMD
			TS	-5,12	9050E	AMD
			TS	±5,12	EA2107B	EA
			TS	±5,12	EA4060-2	EA
			TS	±5,12	FM40273	Fairchild
			TS	±5,12	EA4116	EA
			TS	±5,12	EA4122-2	EA
			TS	±5,12	MB8107H	Fujitsu
			TS	±5,12	2104A-2	Intel
			TS	±5,12	2107B	Intel
			TS	±5,12	IM7505A-2	Intersil
			TS	±5,12	IM7507-2	Intersil
			TS	±5,12	MK4027-3	Mostek
			TS	±5,12	MCM6605A-2	Motorola
			TS	-5,12	**MM5270**	**National (783)**
			TS	-5,12	**MM5271**	**National (791)**
			TS	±5,12	**MM5280**	**National (794)**
			TS	±5,12	**MM5281**	**National (802)**
			TS	±5,12	μPD411A	NEC
			TS	±5,12	μPD411-2	NEC
			TS	-5,12	μPD418-2	NEC
			TS	±5,12	MN1001-2	Panasonic
			TS	-5,12	MW4050V2	RCA
			TS	-5,12	MW4051V2	RCA
			TS	±5,12	MW4060V2	RCA
			TS	±5,12	4096	Rockwell
			TS	±5,12	2675	Signetics
			TS	±5,12	2680	Signetics
			TS	-5,12	SY5270	Synertek
			TS	±5,12	SY5280	Synertek
			TS	-3,5,12	**TMS4030-2**	**TI (854)**
			TS	±5,12	**TMS4060-2**	**TI (854)**
			TS	-5,12	**TMS4050-2**	**TI (854)**
			TS	±5,12	TMM411	Toshiba
			TS	±5,12	RM1701H-20	Western
		220 nsF	TS	±5,12	EA2107B-2	EA
		230 nsF	TS	±5,12	MB8224E	Fujitsu
		250 nsF	TS	±5,12	9060D	AMD
			TS	-5,12	9050D	AMD
			TS	±5,12	7005-11	Intersil
			TS	±5,12	7027-11	Intersil
			TS	-5,12	7271A-12	Intersil
			TS	±5,12	EA4060-1	EA
			TS	±5,12	EA4122-1	EA
			TS	±5,12	40963	Fairchild
			TS	±5,12	MB8107E	Fujitsu
			TS	±5,12	2104A-3	Intel
			TS	±5,12	IM7507-1	Intersil
			TS	±5,12	MK4096-6	Mostek
			TS	±5,12	MK40223	Mostek
			TS	±5,12	MCM6604-2	Motorola
			TS	±5,12	2180-4	MMI
				(Cont'd)		

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

Bold face indicates additional data is provided on the page noted.

MEMORY—RAMs (Cont'd)

Dynamic (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
4096 x 1	NMOS	250 nsF			(Cont'd)	
			TS	-5,12	**MM5271**	**National (791)**
			TS	±5,12	**MM5281**	**National (802)**
			TS	±5,12	μPD411-1	NEC
			TS	-5,12	μPD414-1	NEC
			—	-5,12	μPD418-1	NEC
			TS	±5,12	MW1011-1	Panasonic
			TS	±5,12	MW4104V2	RCA
			TS	-5,12	MW4050V1	RCA
			TS	-5,12	MW4051V1	RCA
			TS	±5,12	MW4060V1	RCA
			TS	±5,12	2660-3	Signetics
			TS	-5,12	SY5271	Synertek
			TS	±5,12	SY5281	Synertek
			TS	-3,5,12	**TMS4030-1**	**TI (854)**
			TS	±5,12	**TMS4060-1**	**TI (854)**
			TS	-5,12	**TMS4050-1**	**TI (854)**
			TS	-5,12	**TMS4051-1**	**TI (854)**
			TS	±5,12	TMM412	Toshiba
			TS	±5,12	RM1701H-25	Western
		270 nsF	TS	-5,12	7270-12	Intersil
			TS	±5,12	7280-12	Intersil
			TS	±5,12	EA2107B-4	EA
			TS	±5,12	2107B-4	Intel
			TS	-5,12	2170	MMI
			TS	±5,12	2180	MMI
			TS	-5,12	**MM4270**	**National (777)**
			TS	±5,12	**MM4280**	**National (780)**
			TS	-5,12	**MM5270-5**	**National (789)**
			TS	±5,12	**MM5280-5**	**National (800)**
			TS	±5,12	2680-1	Signetics
		280 nsF	TS	±5,12	MB8224N	Fujitsu
			TS	±5,12	2107A-1	Intel
		300 nsF	TS	±5,12	9060C	AMD
			TS	-5,12	9050C	AMD
			TS	±5,12	7005-12	Intersil
			TS	±5,12	EA2107B-L	EA
			TS	±5,12	EA4060	EA
			TS	±5,12	EA4122	EA
			TS	±5,12	40964	Fairchild
			TS	±5,12	FM40274	Fairchild
			TS	±5,12	MB8107N	Fujitsu
			TS	±5,12	HM4503-1	Hitachi
			TS	±5,12	HM4507	Hitachi
			TS	±5,12	2104A-4	Intel
			TS	±5,12	2107A	Intel
			TS	±5,12	2107B-5	Intel
			TS	±5,12	IM7505A	Intersil
			TS	±5,12	IM7507	Intersil
			TS	±5,12	MK4027-4	Mostek
			TS	±5,12	MK4096-16	Mostek
			TS	±5,12	MK4200-16	Mostek
			TS	±5,12	MCM6604-4	Motorola
			TS	±5,12	MCM6605A	Motorola
			TS	±5,12	μPD411	NEC
			—	-5,12	μPD414	NEC
			TS	±5,12	MN1001	Panasonic
			TS	±5,12	MW4060	RCA
			TS	±5,12	MW4101V1	RCA
			TS	-5,12	MW4050	RCA
			TS	-5,12	MW4051	RCA
			TS	±5,12	4096-4	Rockwell
			TS	-5,12	HYB4060	Siemens
			TS	±5,12	2660-1	Signetics
				(Cont'd)		

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
Dynamic (Cont'd)						
4096 x 1	NMOS	300 nsF			(Cont'd)	
			TS	±5,12	**TMS4060**	**TI (854)**
			TS	-5,12	**TMS4050**	**TI (854)**
			TS	-5,12	**TMS4051**	**TI (854)**
			TS	-3,5,12	**TMS4030**	**TI (854)**
			TS	±5,12	RM1701H	Western
			TS	±5,12	RM1701H-30	Western
		350 nsF	TS	±5,12	9107-6	AMD
			TS	±5,12	40965	Fairchild
			TS	±5,12	2104A	Intel
			TS	±5,12	2107A-4	Intel
			TS	±5,12	2107B-6	Intel
			TS	±5,12	2180	MMI
			TS	-5,12	2170	MMI
			TS	±5,12	MK4096-11	Mostek
			TS	±5,12	MK4096-85	Mostek
			TS	±5,12	MK4200-11	Mostek
			TS	±5,12	MCM6604	Motorola
			TS	±5,12	μPD411-E	NEC
			TS	±5,12	μPD414-E	NEC
			TS	±5,12	MW4101	RCA
			TS	±5,12	4096-5	Rockwell
			TS	±5,12	2660-2	Signetics
			TS	±5,12	2680-2	Signetics
		400 nsF	TS	±5,12	HM4503	Hitachi
			TS	±5,12	2675	Signetics
			TS	±5,12	RM1701H-40	Western
		420 nsF	TS	±5,12	2107A-5	Intel
			TS	±5,12	2107A-8	Intel
8192 x 1	NMOS	150 nsF	TS	±5,12	7008-10	Intersil
		200 nsF	TS	±5,12	7008-11	Intersil
			TS	±5,12	2108	Intel
16384 x 1	NMOS	150 nsF	TS	±5,12	MK4116-2	Mostek
		200 nsF	TS	±5,12	MK4116-3	Mostek
		250 nsF	TS	±5,12	F16K3	Fairchild
			TS	±5,12	MB8116	Fujitsu
			TS	±5,12	**2116-2**	**Intel (687)**
			TS	±5,12	7116-11	Intersil
			TS	±5,12	MK4116-4	Mostek
			TS	±5,12	MCM6616-2	Motorola
			TS	±5,12	μPD416-1	NEC
			TS	±5,12	TMS4070-2	TI
		300 nsF	TS	±5,12	F16K4	Fairchild
			TS	±5,12	**2116-4**	**Intel (687)**
			TS	±5,12	MCM6616-4	Motorola
			TS	±5,12	TMS4070-1	TI
		350 nsF	TS	±5,12	F16K5	Fairchild
			TS	±5,12	**2116**	**Intel (687)**
			TS	±5,12	MCM6616	Motorola
			TS	±5,12	**TMS4070**	**TI (852)**

CCD Memories

9216-Bits (1024x9)	CCD450	Fairchild
	CCD451	Fairchild
	CCD450A	Fairchild
	CCD451A	Fairchild
16384-Bits (128x32x4)	CCD460	Fairchild
16384-Bits (256x64x1)	2416	Intel
	(Cont'd)	

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

MEMORY—RAMs (Cont'd)

CCD Memories (Cont'd)

Static

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
16384-Bits (256x64x1)					(Cont'd)	
					2444	Intel
4 x 4	CMOS	1 μsR	—	4.5-15	MC14580BA	† Motorola
		1.5 μsR	—	3-15	MC14580BC	Motorola
	TTL	30 nsF	OC	5	3104	Intel
		40 nsR	OC	5	SN54LS170	† AMD
			TS	5	SN54LS670	† AMD
			OC	5	SN74LS170	AMD
			TS	5	SN74LS670	AMD
			OC	5	54170	† Fairchild
			OC	5	54LS170	† Fairchild
			TS	5	54LS670	† Fairchild
			OC	5	74170	Fairchild
			OC	5	74LS170	Fairchild
			TS	5	74LS670	Fairchild
			OC	5	ZN54170	† Ferranti
			OC	5	ZN74170	Ferranti
			OC	5	54170	† Raytheon
			OC	5	74170	Raytheon
			OC	5	DM54170	† National
			OC	5	DM54LS170	† National
			TS	5	DM54LS670	† National
			OC	5	DM74170	National
			OC	5	DM74LS170	National
			TS	5	DM74LS670	National
			OC	5	74LS170	Signetics
			OC	5	54LS170	† Signetics
			TS	5	74LS670	Signetics
			TS	5	54LS670	† Signetics
			OC	5	SN54170	† TI
			OC	5	SN54LS170	† TI
			TS	5	SN54LS670	† TI
			OC	5	SN74170	TI
			OC	5	SN74LS170	TI
			TS	5	SN74LS670	TI
4 x 8	CMOS	1 μsR		3-15	CD4036B	† RCA
				3-15	CD4039B	† RCA
				3-15	CM4036A	† Solitron
				3-15	CM4039A	† Solitron
8 x 2	ECL	14.5 nsR		-5.2	MCM10143	Motorola
	TTL	50 nsR	TS	5	SN74172	TI
8 x 4	TTL	30 nsF		5	N82S12	Signetics
8 x 8	TTL	30 nsF		5	N82S112	Signetics
16 x 1	ECL	12 nsR		12	HM2101	Hitachi
	TTL	20 nsR	OC	5	5481	† Raytheon
			OC	5	7481	Raytheon
			OC	5	SN5481A	† TI
			OC	5	SN5484A	† TI
			OC	5	SN7481A	TI
			OC	5	SN7484A	TI
		35 nsR	OC	5	MC4004	Motorola
			OC	5	MC4005	Motorola

(Cont'd)

Static (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
16 x 1	TTL	35 nsR	OC		(Cont'd)	
			OC	5	MC4304	† Motorola
			OC	5	MC4305	† Motorola
16 x 4	CMOS	120 nsR	TS	3-5	F4710BC	Fairchild
			TS	—	F4710BM	† Fairchild
		280 nsR	TS	3-15	HD54C89	† Harris
			TS	3-15	HD74C89	Harris
			TS	3-15	**MM54C89**	**† National (805)**
			TS	3-15	**MM74C89**	**National (805)**
	ECL	6 nsR	OE	-5.2	F10145	Fairchild
		10 ns	OE	-5.2	HD10145	Hitachi
			OE	-5.2	MCM10145	† Motorola
		15 nsR	OE	-5.2	10145	Signetics
	TTL	19 nsF	TS	—	9410C	Fairchild
		35 nsF	OC	5	AM27S02C	AMD
			TS	5	AM27S03C	AMD
			TS	5	SN74S189	AMD
			OC	5	SN74S289	AMD
			OC	5	93404C	Fairchild
			OC	5	93404M	† Fairchild
			TS	5	93405C	Fairchild
			OC	5	93405M	† Fairchild
			OC	5	3101A	Intel
			OC	5	6560	MMI
			TS	5	6561	MMI
			OC	5	DM74S289	National
			TS	5	**DM74S189**	**National (746)**
			OC	5	μPB2289	NEC
			OC	5	N3101A	Signetics
			TS	5	74S189	Signetics
			TS	5	SN74S189	TI
			OC	5	SN74S289	TI
		40 nsF	TS	5	**DM85S68**	**National (749)**
		45 nsF	OC	5	AM27S02M	† AMD
			TS	5	AM27S03M	† AMD
			OC	5	M3101A	† Intel
		45 nsR	OC	5	MC5484	† Motorola
			OC	5	MC7484	Motorola
		50 nsF	TS	5	SN54S189	† AMD
			OC	5	SN54S289	† AMD
			OC	5	DM54S289	† National
			TS	5	**DM54S189**	**† National (746)**
			TS	5	**DM8599**	**National (704)**
			OC	5	N82S25	Signetics
			OC	5	S3101A	† Signetics
			OC	5	74S89	Signetics
			TS	5	54S189	† Signetics
			TS	5	SN54S189	† TI
			OC	5	SN54S289	† TI
		55 nsF	TS	5	**DM75S68**	**† National (749)**
		60 nsF	OC	5	3101	AMD
			OC	5	3101	Intel

(Cont'd)

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

Bold face indicates additional data is provided on the page noted.

MEMORY—RAMs (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
Static (Cont'd)						
16 x 4	TTL	60 nsF			(Cont'd)	
			OC	5	5560	† MMI
			TS	5	5561	† MMI
			OC	5	**DM7489**	**National (704,741)**
			OC	5	μPB2089	NEC
			OC	5	54S89	† Signetics
		60 nsR	OC	5	SN7489	AMD
			OC	5	7489	Fairchild
			OC	5	HM2502	Hitachi
			OC	5	IM5501C	Intersil
			OC	5	IM5501M	† Intersil
			OC	5	MCM4064	Motorola
			OC	5	MCM4364	† Motorola
			OC	5	TL7489	Telefunken
			OC	5	SN7489	TI
			OC	5	7489	TRW
		70 nsF	OC	5	AM27LS02C	AMD
			TS	5	AM27LS03C	AMD
			TS	5	**DM7599**	† **National (704)**
			TS	5	**DM74LS189**	**National (743)**
		75 nsF	OC	5	31013	† AMD
			OC	5	M3101	† Intel
		80 nsF	OC	5	L6560	MMI
			TS	5	L6561	MMI
			OC	5	**DM5489**	† **National (704,741)**
			OC	5	DM74LS289	National
		85 nsF	OC	5	AM27LS02M	† AMD
			TS	5	AM27LS03M	† AMD
		100 nsF	OC	5	L5560	† MMI
			TS	5	L5561	† MMI
			OC	5	DM54LS289	† National
			TS	5	**DM54LS189**	† **National (743)**
		110 nsR	OC	5	31L01C	AMD
			OC	5	31L01M	† AMD
32 x 2	TTL	50 nsF	OC	5	DM86S21	National
			OC	5	N82S21	Signetics
64 x 1	CMOS	270 nsR	—	3-18	MCM14505BA	† Motorola
		350 nsR	—	4.5-16	MCM14505BC	Motorola
	ECL	10 nsR	OE	-5.2	SN10142	TI
		12 nsR	OE	-5.2	MCM10140	Motorola
			OE	-5.2	MCM10142	Motorola
			OE	-5.2	MCM10148	Motorola
			OE	-5.2	μPB10142	NEC
		15 nsR	OE	-5.2	μPB10148	NEC
			OE	-5.2	10140	Signetics
			OE	-5.2	10148	Signetics
			OE	-5.2	10151	Signetics
			OE	-5.2	SN10140	TI
			OE	-5.2	SN10148	TI
64 x 4	CMOS	200 ns	TS	5-15	SCM5555D	SSS
		700 nsF	TS	5	**MM74C910**	**National (811)**
		860 nsF	TS	5	**MM54C910**	† **National (811)**
		1.05 μsR	TS	5-15	MCM14552A	† Motorola
		2.1 μsR	TS	5-15 (Cont'd)	MCM14552C	Motorola

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
Static (Cont'd)						
64 x 4					(Cont'd)	
	NMOS	450 nsF	TS	5	**TMS4036-2**	**TI (857)**
		650 nsF	TS	5	**TMS4036-1**	**TI (857)**
		1 μsF	TS	5	**TMS4036**	**TI (857)**
64 x 9	TTL	45 nsF	OC	5	93419C	Fairchild
			OC	5	N82S09	Signetics
		60 nsF	OC	5	93419M	† Fairchild
		65 nsF	OC	5	S82S09	† Signetics
128 x 1	ECL	12 nsR	OE	-5.2	MCM10147	Motorola
			OE	-5.2	GXB10147	Siemens
		14 nsF	OE	-5.2	MB7047	Fujitsu
		15 nsF	OE	-5.2	F10405C	Fairchild
		15 nsR	OE	-5.2	SN10147	TI
128 x 4	PMOS	1 μsF		±5	TMM111	Toshiba
128 x 8	CMOS	150 ns		5	MWS5080	RCA
	NMOS	350 nsF		5	S6810A	AMI
		450 nsF	TS	5	S6810A-1	AMI
		350 nsF		5	MCM6810A	Motorola
		450 nsF	TS	5	MCM6810A-1	Motorola
		575 nsF	TS	5	**S6810-1**	**AMI (889)**
		1 μsF	TS	5	**S6810**	**AMI (889,649,916)**
128 x 9	CMOS	500 nsF		5	MN1101	Panasonic
256 x 1	CMOS	100 nsF	TS	3-15	SCM5520S	† SSS
		150 ns	TS	10	CD40061A	† RCA
		200 ns	TS	3-15	F4720BC	Fairchild
			TS	3-15	F4720BM	† Fairchild
		300 ns	TS	5	CD40061	RCA
			OC	5	AM29720C	AMD
		380 nsR	TS	3-15	CD4061A	† RCA
		400 nsR	TS	3-15	HD54C200	† Harris
			TS	3-15	HD74C200	Harris
			TS	3-15	**MM54C200**	† **National (808)**
			TS	3-15	**MM74C200**	**National (808)**
		500 nsR	—	3-7	IM6523C	Intersil
			—	3-7	IM6523M	† Intersil
		1.4 μsR	—	3-15	MCM14537A	† Motorola
		2 μsR	—	3-15	MCM14537C	Motorola
	ECL	15 nsF	OE	-5.2	MB7042	Fujitsu
			OE	-5.2	10414	Fairchild
		25 nsF	OE	-5.2	μPB10144	NEC
		30 nsF	OE	-5.2	F10410C	Fairchild
			OE	-5.2	10144	Signetics
		30 nsR	OE	-5.2	MCM10144	Motorola
		35 nsF	OE	-4.25	F10411C	Fairchild
			OE	-5.2	MBM10410	Fujitsu
			OE	-5.2	HM2105	Hitachi
			OE	-5.2	RC10144	Raytheon
		35 nsR	OE	-5.2	SN10144	TI
		40 nsF	OE	-5.2 (Cont'd)	RI10144	Raytheon

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

MEMORY—RAMs (Cont'd)

Static (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
256 x 1					(Cont'd)	
	PMOS	500 nsF	TS	-9,5	MM1101A2	National
		650 nsF	TS	-9,5	MM4250	† National
		800 nsF	—	-7,5	IM7511C	Intersil
		900 nsF		-12,5	MK4007	Mostek
		1 μsF	TS	-9.5	MM1101A1	National
		1 μsR	TS	-9,5	1101A1	AMD
			TS	-9,5	1101A1	Intel
			TS	-7,5	IM7511M	† Intersil
		1.5 μsF	TS	-9,5	1101A	AMD
			TS	-10,5	1101AM	† AMD
			TS	-9,5	1101A	Intel
			TS	-7,5	IM7501C	Intersil
			TS	-7,5	IM7501M	† Intersil
			TS	-7,5	IM7512C	Intersil
			TS	-9,5	MM1101A	National
		1.8 μsF	TS	-7,5	IM7512M	† Intersil
	TTL	35 nsF	TS	5	AM27LS00AC	AMD
		40 nsF	TS	5	93421AC	Fairchild
			TS	5	N82S116	Signetics
			TS	5	93421AC	Raytheon
			OC	5	N82S117	Signetics
		45 nsF	OC	5	AM27LS01C	AMD
			OC	5	AM29720C	AMD
			TS	5	AM27LS00C	AMD
			TS	5	AM27LS00AM	† AMD
			TS	5	AM29721C	AMD
			OC	5	93410AC	Fairchild
			OC	5	93411AC	Fairchild
			TS	5	93L420C	Fairchild
			OC	5	93411AC	Raytheon
		50 nsF	TS	5	93421C	Fairchild
			TS	5	MM74S200	National
			TS	5	μPB2200	NEC
			TS	5	RC5340	Raytheon
			TS	5	93421C	Raytheon
			OC	5	N82S17	Signetics
			TS	5	N82S16	Signetics
			OC	5	74S301	Signetics
			TS	5	74S200	Signetics
			TS	5	74S201	Signetics
		55 nsF	OC	5	AM27LS01M	† AMD
			OC	5	AM29720M	† AMD
			TS	5	AM27LS00M	† AMD
			TS	5	AM29721M	† AMD
			OC	5	93411C	Fairchild
			TS	5	93L420M	† Fairchild
			OC	5	6530	MMI
			TS	5	6531	MMI
			OC	5	RC5330	Raytheon
			OC	5	93411C	Raytheon
		60 nsF	OC	5	AM27S01BC	AMD
			TS	5	AM27S00BC	AMD
			OC	5	93410C	Fairchild
				(Cont'd)		

Static (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
256 x 1	TTL	60 nsF			(Cont'd)	
			TS	5	93421M	† Fairchild
			TS	5	3106A	Intel
			OC	5	3107A	Intel
			OC	5	IM5503AC	Intersil
			TS	5	IM5523AC	Intersil
			OC	5	IM5533AC	Intersil
			OC	5	**DM74S206**	**National (751)**
			OC	5	μPB2206	NEC
			OC	5	93421M	† Raytheon
		65 nsF	OC	5	93411M	† Fairchild
			TS	5	HM2505	Hitachi
			TS	5	μPB2202	NEC
			OC	5	93411M	† Raytheon
			TS	5	SN74S201	TI
			OC	5	SN74S301	TI
		70 nsF	OC	5	93410M	† Fairchild
			OC	5	IM5503AM	† Intersil
			TS	5	IM5523AM	† Intersil
			OC	5	IM5533AM	† Intersil
			OC	5	5530	† MMI
			TS	5	5531	† MMI
			TS	5	**DM54S200**	† **National (704)**
			TS	5	RM5340	† Raytheon
			OC	5	S82S17	† Signetics
			TS	5	S82S16	† Signetics
			OC	5	S54S301	† Signetics
			TS	5	54S200	† Signetics
			TS	5	54S201	† Signetics
			TS	5	TL74200	Telefunken
		75 nsF	OC	5	RM5330	† Raytheon
		80 nsF	OC	5	AM27LS01LC	AMD
			TS	5	AM27LS00LC	AMD
			TS	5	3106-8	Intel
			OC	5	3107-8	Intel
			TS	5	3106	Intel
			OC	5	3107	Intel
			OC	5	IM5503C	Intersil
			TS	5	IM5523C	Intersil
			OC	5	IM5533C	Intersil
			OC	5	**DM54S206**	† **National (751)**
		80 nsR	OC	5	IM5503M	† Intersil
			TS	5	IM5523M	† Intersil
			OC	5	IM5533M	† Intersil
		85 nsF	OC	5	SN54S301	† TI
			TS	5	SN54S201	† TI
		90 nsF	TS	5	93L421C	Fairchild
		95 nsF	OC	5	AM27LS01LM	† AMD
			TS	5	AM27LS00LM	† AMD
		100 nsF	TS	5	93L421M	† Fairchild
		115 nsF	OC	5	L6530	MMI
			TS	5	L6531	MMI
				(Cont'd)		

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

Bold face indicates additional data is provided on the page noted.

MEMORY—RAMs (Cont'd)

Static (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
256 x 1	TTL				(Cont'd)	
		130 nsF	OC	5	L5530	† MMI
			TS	5	L5531	† MMI
256 x 4	CMOS	80 ns	TS	5	MWS5040A	RCA
		90 ns	TS	10	MWS5040	RCA
		100 nsF	TS		SCL5501S	† SSS
		100 nsR	TS	4-11	**HM6551A-9**	**Harris (676)**
			TS	4-11	**HM6561A-9**	**Harris (677)**
			TS	4-11	**HM6562A-9**	**Harris (678)**
			TS	4-11	**HM6551A-2**	**† Harris (676)**
			TS	4-11	**HM6561A-2**	**† Harris (677)**
			TS	4-11	**HM6562A-2**	**† Harris (678)**
		160 nsR	TS	4-11	**HM6551C-9**	**Harris (676)**
			TS	4-11	**HM6561C-9**	**Harris (677)**
			TS	4-11	**HM6562C-9**	**Harris (678)**
			TS	4-11	**HM6551C-2**	**† Harris (676)**
			TS	4-11	**HM6561C-2**	**† Harris (677)**
			TS	4-11	**HM6562C-2**	**† Harris (678)**
		250 nsF	TS	5	**MM74C920**	**National (814)**
			TS	5	**MM74C921**	**National (816)**
		275 nsF	TS	5	**MM54C920**	**† National (814)**
			TS	5	**MM74C921**	**† National (816)**
		300 nsF	TS	5	**HM6501B-9**	**Harris (675)**
			TS	5	**HM6551B-9**	**Harris (676)**
			TS	5	**HM6561B-9**	**Harris (677)**
			TS	5	**HM6562B-9**	**Harris (678)**
			TS	5	**HM6501B-2**	**† Harris (675)**
			TS	5	**HM6551B-2**	**† Harris (676)**
			TS	5	**HM6561B-2**	**† Harris (677)**
			TS	5	**HM6562B-2**	**† Harris (678)**
		425 nsF	TS	5	**HM6501-9**	**Harris (675)**
			TS	5	**HM6551-9**	**Harris (676)**
			TS	5	**HM6561-9**	**Harris (677)**
			TS	5	**HM6562-9**	**Harris (678)**
		450 nsF	TS	5	**S5101L-1**	**AMI (639)**
			TS	5	**S5101L-2**	**AMI (639)**
			TS	5	**S5101-1**	**AMI (639)**
			TS	5	**S5101-2**	**AMI (639)**
			TS	5	5101-1	Intel
			TS	5	5101L-1	Intel
		475 nsF	TS	5	**HM6501-2**	**† Harris (675)**
			TS	5	**HM6551-2**	**† Harris (676)**
			TS	5	**HM6561-2**	**† Harris (677)**
			TS	5	**HM6562-2**	**† Harris (678)**
		550 nsF	TS	5	TC5007-1	Toshiba
		650 nsF	TS	5	**S5101**	**AMI (639)**
			TS	5	**S5101-3**	**AMI (639)**
			TS	5	**S5101L**	**AMI (639)**
			TS	5	**S5101L-3**	**AMI (639)**
			TS	5	5101	Intel
			TS	5	5101L	Intel
			TS	5	5101-3	Intel
			TS	5	5101L-3	Intel
			TS	5	SY5101	Synertek
			TS	5	SY5111	Synertek
			TS	5	SY5112	Synertek
		800 nsF	TS	5	**S5101-8**	**AMI (639)**
			TS	5	5101-8	Intel
					(Cont'd)	

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
Static (Cont'd)						
256 x 4	CMOS	800 nsF			(Cont'd)	
			TS	5	TC5007-2	Toshiba
		1000 nsF	TS	5	μPD5101-E	NEC
	NMOS	150 nsF	TS	5	SY21H01-1	Synertek
			TS	5	SY21H11-1	Synertek
			TS	5	SY21H12-1	Synertek
		175 nsF	TS	5	SY21H01	Synertek
			TS	5	SY21H11	Synertek
			TS	5	SY21H12	Synertek
		200 nsF	TS	5	SY21H01-2	Synertek
			TS	5	SY21H11-2	Synertek
			TS	5	SY21H12-2	Synertek
		250 nsF	TS	5	7101-11	Intersil
			TS	5	7111-11	Intersil
			TS	5	7112-11	Intersil
			TS	5	9101D	AMD
			TS	5	9111D	AMD
			TS	5	9112D	AMD
			TS	5	2101A-2	Intel
			TS	5	2111A-2	Intel
			TS	5	2112A-2	Intel
			TS	5	μPD2101-2	NEC
			TS	5	μPD2102-2	NEC
			TS	5	μPD2111-2	NEC
			TS	5	MW4101V2	RCA
			TS	5	MW4111V2	RCA
			TS	5	MW4112V2	RCA
			TS	5	SY2101A-2	Synertek
			TS	5	SY2111A-2	Synertek
			TS	5	SY2112A-2	Synertek
		300 nsF	TS	5	91L01C	AMD
			TS	5	9101C	AMD
			TS	5	9101CM	† AMD
			TS	5	91L11C	AMD
			TS	5	9111C	AMD
			TS	5	911CM	† AMD
			TS	5	91L12C	AMD
			TS	5	9112C	AMD
			TS	5	9112CM	† AMD
			TS	5	7101-32	Intersil
			TS	5	7111-32	Intersil
			TS	5	7112-32	Intersil
			TS	5	EA2101	EA
			TS	5	EA2111	EA
			TS	5	EA2112	EA
			TS	5	MW4101V1	RCA
			TS	5	MW4111V1	RCA
			TS	5	MW4112V1	RCA
			TS	5	**TMS2101**	**TI (857)**
			TS	5	**TMS2102**	**TI (857)**
			TS	5	**TMS2112**	**TI (857)**
		350 nsF	TS	5	3538F	Fairchild
			TS	5	2101A	Intel
			TS	5	2111A	Intel
			TS	5	2112A	Intel
			TS	5	μPD2101	NEC
			TS	5	μPD2102	NEC
			TS	5	μPD2111	NEC
			TS	5	SY2101A	Synertek
			TS	5	SY2111A	Synertek
			TS	5	SY2112A	Synertek
		400 nsF	TS	5	91L01B	AMD
			TS	5	9101B	AMD
			TS	5	9101BM	† AMD
					(Cont'd)	

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

MEMORY—RAMs (Cont'd)

Static (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
256 x 4	NMOS	400 nsF			(Cont'd)	
			TS	5	91L11B	AMD
			TS	5	9111B	AMD
			TS	5	9111BM	† AMD
			TS	5	91L12B	AMD
			TS	5	9112B	AMD
			TS	5	9112BM	† AMD
			TS	5	7112-13	Intersil
			TS	5	7101-13	Intersil
			TS	5	7111-13	Intersil
			TS	5	7101-33	Intersil
			TS	5	7111-33	Intersil
			TS	5	7112-33	Intersil
			TS	5	EA2101M	† EA
			TS	5	EA2111M	† EA
			TS	5	EA2112M	† EA
			TS	5	MW4101	RCA
			TS	5	MW4111	RCA
			TS	5	MW4112	RCA
			TS	5	2601	Signetics
			TS	5	2611	Signetics
			TS	5	2612	Signetics
		450 nsF	TS	5	3538-1	Fairchild
			TS	5	2101A-4	Intel
			TS	5	2111A-4	Intel
			TS	5	2112A-4	Intel
			TS	5	μPD2101-4	NEC
			TS	5	μPD2102-4	NEC
			TS	5	μPD2111-4	NEC
			TS	5	μPD2112-4	NEC
			TS	5	SY2101A-4	Synertek
			TS	5	SY2111A-4	Synertek
			TS	5	SY2112A-4	Synertek
			TS	5	TMS4039-2	TI
			TS	5	TMS4042-2	TI
			TS	5	TMS4043-2	TI
		500 nsF	TS	5	2101-1	AMD
			TS	5	2111-1	AMD
			TS	5	2112-1	AMD
			TS	5	91L01A	AMD
			TS	5	9101A	AMD
			TS	5	9101AM	† AMD
			TS	5	91L11A	AMD
			TS	5	9111A	AMD
			TS	5	9111AM	† AMD
			TS	5	91L12A	AMD
			TS	5	9112A	AMD
			TS	5	9112AM	† AMD
			TS	5	RA3-4256	EMM/Semi
			TS	5	RA3-4256	GI
			TS	5	7101-14	Intersil
			TS	5	7111-14	Intersil
			TS	5	7112-14	Intersil
			TS	5	7101-34	Intersil
			TS	5	7111-34	Intersil
			TS	5	7112-34	Intersil
			TS	5	**MM2101-1**	**National (756)**
			TS	5	**MM2111-1**	**National (768)**
			TS	5	MM5269-1	National
			TS	5	2101-1	Signetics
			TS	5	2111-1	Signetics
			TS	5	2606-1	Signetics
			TS	5	SY2111-1	Synertek
			TS	5	SY2112-1	Synertek
			TS	5	SY2113-1	Synertek
			TS	5	SY2101-1	Synertek
			TS	5	SY2111-1	Synertek
					(Cont'd)	

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
Static (Cont'd)						
256 x 4	NMOS	500 nsF			(Cont'd)	
			TS	5	SY2112-1	Synertek
		650 nsF	TS	5	2101-2	AMD
			TS	5	2111-2	AMD
			TS	5	2112-2	AMD
			TS	5	RA3-4265B	EMM/Semi
			TS	5	RA3-4256A	EMM/Semi
			TS	5	3538-2	Fairchild
			TS	5	RA3-4256A	GI
			TS	5	RA3-4256B	GI
			TS	5	**MM2101-2**	**National (756)**
			TS	5	**MM2111-2**	**National (768)**
			TS	5	**MM2112-2**	**National (771)**
			TS	5	MM5269-2	National
			TS	5	2101-2	Signetics
			TS	5	2111-2	Signetics
			TS	5	2112-2	Signetics
			TS	5	SY2101-2	Synertek
			TS	5	SY2111-2	Synertek
			TS	5	SY2112-2	Synertek
			TS	5	TMS4039-1	TI
			TS	5	TMS4042-1	TI
			TS	5	TMS4043-1	TI
			TS	5	TMM311-1	Toshiba
			TS	5	TMM312-1	Toshiba
		750 nsF	TS	5	2606	Signetics
		1 μsF	TS	5	2101	AMD
			TS	5	2111	AMD
			TS	5	2112	AMD
			TS	5	RA3-4256	EMM/Semi
			TS	5	RA3-4256B	EMM/Semi
			TS	5	7101-15	Intersil
			TS	5	7111-15	Intersil
			TS	5	7112-15	Intersil
			TS	5	**MM2101**	**National (756)**
			TS	5	**MM2111**	**National (768)**
			TS	5	**MM2112**	**National (771)**
			TS	5	**MM5269**	**National (775)**
			TS	±5,12	μPD412	NEC
			TS	5	2101	Signetics
			TS	5	2111	Signetics
			TS	5	2112	Signetics
			TS	5	SY2101	Synertek
			TS	5	SY2111	Synertek
			TS	5	SY2112	Synertek
			TS	5	TMS4039	TI
			TS	5	TMS4042	TI
			TS	5	TMS4043	TI
			TS	5	TMM311	Toshiba
			TS	5	TMM312	Toshiba
	TTL	60 nsF	OC	5	93L412C	Fairchild
			TS	5	93L422C	Fairchild
		75 nsF	OC	5	93L412M	† Fairchild
			TS	5	93L422M	† Fairchild
256 x 8	NMOS	400 nsF		5	3539-1	Fairchild
		500 nsF	TS	5	3539-2	Fairchild
		600 nsF	TS	5	3539	Fairchild
512 x 1	CMOS	200 nsF		10	**S2222**	**AMI (634)**
				10	2222	Nortec
				10	SCM5522	SSS
		400 nsF		10	**S2222A**	**AMI (634)**
				10	2222A	Nortec
				(Cont'd)		

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

Bold face indicates additional data is provided on the page noted.

MEMORY—RAMs (Cont'd)

Static (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
1024 x 1					(Cont'd)	
	CMOS	80 ns	TS	5	MWS5001A	RCA
		90 ns	TS	10	MWS5501	RCA
		95 nsR	TS	10	IM6508A-1	Intersil
			TS	10	IM6518A-1	Intersil
		100 nsF	TS	3-15	SCM5502S	† SSS
		100 nsR	TS	4-11	**HM6508A-9**	**Harris (679)**
			TS	4-11	**HM6518A-9**	**Harris (679)**
			TS	4-11	**HM6508A-2**	**† Harris (679)**
			TS	4-11	**HM6518A-2**	**† Harris (679)**
		150 nsR	TS	10	IM6508A	Intersil
			TS	10	IM6518A	Intersil
		150 ns	TS	5	MWS5001	RCA
		160 nsR	TS	4-11	**HM6508C-9**	**Harris (679)**
			TS	4-11	**HM6518C-9**	**Harris (679)**
			TS	4-11	**HM6508C-2**	**† Harris (679)**
			TS	4-11	**HM6518C-2**	**† Harris (679)**
		200 nsF	TS	4-11	**S6508A**	**AMI (645)**
		250 nsF	TS	3-10	IM6508C	Intersil
			TS	3-10	IM6508M	† Intersil
			TS	3-10	IM6518C	Intersil
			TS	3-10	IM6518M	† Intersil
			TS	5	**MM74C929**	**National (816)**
			TS	5	**MM74C930**	**National (816)**
		275 nsF	TS	5	**MM54C929**	**† National (816)**
			TS	5	**MM54C930**	**† National (816)**
		300 nsF	TS	5	S6508-1	AMI
			TS	5	IM6508-1	Intersil
			TS	5	IM6518-1	Intersil
		305 nsF	TS	5	**HM6508B-9**	**Harris (679)**
			TS	5	**HM6518B-9**	**Harris (679)**
			TS	5	**HM6508B-2**	**† Harris (679)**
			TS	5	**HM6518B-2**	**† Harris (679)**
		350 nsR	TS	4-11	**S6508A**	**AMI (645)**
		425 nsF	TS	5	**HM6508-9**	**Harris (679)**
			TS	5	**HM6518-9**	**Harris (679)**
		460 nsF	TS	5	**S6508**	**AMI (645)**
			TS	5	IM6508	Intersil
			TS	5	IM6518	Intersil
		465 nsF	TS	5	**HM6508-2**	**† Harris (679)**
			TS	5	**HM6518-2**	**† Harris (679)**
		550 nsF	TS	5	TC5016	Toshiba
		650 nsF	TS	5	**HM6508D**	**Harris (679)**
			TS	5	**HM6518D**	**Harris (679)**
		1.5 μsF		5	TC5006	Toshiba
	ECL	15 nsF	OE	-5.2	F10415AC	Fairchild
		29 nsF	OE	-5.2	MCM10146	Motorola
			OE	-5.2	MCM10415	Motorola
		30 nsF	—	-4.5	F100415C	Fairchild
		35 nsF	OE	-5.2	MBM10415A	Fujitsu
		60 nsF	OE	-5.2	MBM10415	Fujitsu
	NMOS	60 nsF		-3,7,15	7001	Intersil
				-3,7,15	MCM7001	Motorola
				-3,7,15	7001	Nortec
				-3,7,15	MW7001I	RCA
				(Cont'd)		

Static (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
1024 x 1	NMOS				(Cont'd)	
		70 nsF	OC	5	**S4015-2**	**AMI (635)**
			TS	5	**S4025-2**	**AMI (635)**
			TS	-3,5,15	1802	EMM/Semi
			OC	5	MBM2115H	Fujitsu
			TS	5	MBM2125H	Fujitsu
			OC	5	**2115-2**	**Intel (683)**
			TS	5	**2125-2**	**Intel (683)**
		75 nsF		-3,7,15	MCM7001-1	Motorola
		90 nsF	TS	-3.5,5,15	1801	EMM/Semi
			OC	5	μPD415	NEC
		95 nsF	OC	5	**S4015**	**AMI (635)**
			TS	5	**S4025**	**AMI (635)**
			OC	5	MBM2115E	Fujitsu
			TS	5	MBM2125E	Fujitsu
			OC	5	**2115**	**Intel (683)**
			TS	5	**2125**	**Intel (683)**
			OC	5	2115L	Intel
			TS	5	2125L	Intel
			OC	5	2115	Signetics
			OC	5	2115L	Signetics
			TS	5	2125	Signetics
			TS	5	2125L	Signetics
		100 nsR	OC	5	IM5508C	Intersil
		100 nsF	—	-3.5,5,15	1218A	EMM/Semi
		120 nsF	TS	5	35422	Fairchild
			OC	5	MBM2115	Fujitsu
			TS	5	MBM2125	Fujitsu
			TS	5	μPD425	NEC
		135 nsF	TS	-3.5,5,15	1217A	EMM/Semi
		150 nsF	TS	5	3542	Fairchild
			TS	5	SY21H02-1	Synertek
			TS	5	SYMC21H02-1	† Synertek
		175 nsF	TS	5	SY21H02	Synertek
		200 nsF	TS	5	SY21H02-2	Synertek
			TS	5	SYMC21H02-2	† Synertek
		250 nsF	TS	5	9102D	AMD
			TS	5	2102H	Fairchild
			TS	5	2102LH	Fairchild
			TS	5	21L02H	Fairchild
			TS	5	2102A-2	Intel
			TS	5	2102AL-2	Intel
			TS	5	MK4102-8	Mostek
			TS	5	**MM2102A-2**	**National (762)**
			TS	5	MM2102AL-2	**National (762)**
			TS	5	21F02-2	Signetics
			TS	5	TMM313-1	Toshiba
		275 nsF	TS	5	MK4102-6	Mostek
			TS	5	SY2102-6	Synertek
		300 nsF	TS	5	91L02C	AMD
			TS	5	91L02CM	† AMD
			TS	5	9102C	AMD
			TS	5	9102CM	† AMD
		350 nsF	TS	5	2102F	Fairchild
				(Cont'd)		

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

MEMORY—RAMs (Cont'd)

Static (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
1024 x 1	NMOS	350 nsF	TS		(Cont'd)	
			TS	5	2102LF	Fairchild
			TS	5	21L02F	Fairchild
			TS	5	2102A	Intel
			TS	5	2102AL	Intel
			TS	5	2102A	Signetics
			TS	5	**MM2102A**	**National (762)**
			TS	5	**MM2102AL**	**National (762)**
			TS	5	21F02	Signetics
			TS	5	SY2102A	Synertek
			TS	5	SYMC2102A	† Synertek
			TS	5	TMM313	Toshiba
		400 nsF	TS	5	91L02B	AMD
			TS	5	9102B	AMD
			TS	5	91L02BM	† AMD
			TS	5	9102BM	† AMD
			TS	5	21L02-3	Signetics
			TS	5	SY21L02B	Synertek
			TS	5	SYMC21L02B	† Synertek
		450 nsF	TS	5	21021	Fairchild
			TS	5	2102L1	Fairchild
			TS	5	21L021	Fairchild
			TS	5	3545	Fairchild
			TS	5	2102A-4	Intel
			TS	5	M2102A-4	† Intel
			TS	5	2102AL-4	Intel
			TS	5	MK4102-1	Mostek
			TS	5	**MM2102A-4**	**National (762)**
			TS	5	MM2102AL-4	**National (762)**
			TS	±5,12	μPD405	NEC
			TS	5	21F02-4	Signetics
			TS	5	TMS4033	TI
		500 nsF	TS	5	2102-1	AMD
			TS	5	9102A	AMD
			TS	5	9102AM	† AMD
			TS	5	91L02A	AMD
			TS	5	91L02AM	† AMD
			TS	5	IM7552-1C	Intersil
			TS	5	**MM2102-1**	**National (759)**
			TS	5	M330C	SGS
			TS	5	21L02-1	Signetics
			TS	5	2102-1	Signetics
			TS	5	SY21L02-1	Synertek
			TS	5	SYMC21L02-1	† Synertek
		650 nsF	TS	5	2102-2	AMD
			TS	5	91L02	AMD
			TS	5	21022	Fairchild
			TS	5	2101L2	Fairchild
			TS	5	21L022	Fairchild
			TS	5	2102A-6	Intel
			TS	5	M2102A-6	† Intel
			TS	5	IM7552-2C	Intersil
			TS	5	**MM2102-2**	**National (759)**
			TS	5	MM2102-2MD	† **National (765)**
			TS	5	**MM2102A-6**	**National (762)**
			TS	5	MM2102AL-6	**National (762)**
			TS	5	M330B	SGS
			TS	5	21L02-2	Signetics
			TS	5	2102-2	Signetics
			TS	5	TMS4034	TI
		650 nsR	TS	5	IM7552-2M	Intersil
		1 μsF	TS	5	2102	AMD
			TS	5	IM7552C	Intersil
			TS	5	MK4102	Mostek
				(Cont'd)		

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
1024 x 1	NMOS	1 μsF	TS		(Cont'd)	
			TS	5	**MM2102**	**National (759)**
		1 nsF	TS	5	MM2102M	† National
			TS	5	**MM2102-MD**	† **National (765)**
			TS	5	21L02	Signetics
			TS	5	2102	Signetics
			TS	5	SY2102	Synertek
			TS	5	SY21L02	Synertek
			TS	5	TMS4035	TI
			TS	5	**TMS2102**	**TI (857)**
		1 μsR	TS	5	IM7552M	† Intersil
	TTL	30 nsF		5	93415AC	Fairchild
			TS	5	93425AC	Fairchild
		30 ns	OC	5	SN54S314	† TI
			OC	5	SN74S314	TI
			TS	5	SN54S214	† TI
			TS	5	SN74S214	TI
			OC	5	**DM93415A**	**National (754)**
			TS	5	**DM93425A**	**National (755)**
		35 ns	OC	5	RM5500	† Raytheon
			OC	5	RC5500	Raytheon
		35 nsF	OC	5	N82S110	Signetics
			TS	5	N82S111	Signetics
		40 ns	OC	5	**DM93415**	**National (754)**
			TS	5	**DM93425**	**National (755)**
		45 nsF	OC	5	93415A	AMD
			OC	5	93415M	† Fairchild
			TS	5	93425M	† Fairchild
			OC	5	IM55S08AC	Intersil
			TS	5	IM55S18AC	Intersil
			OC	5	μPB2205	NEC
			OC	5	93415AC	Raytheon
			TS	5	93425AC	Raytheon
			OC	5	N82S10	Signetics
			TS	5	N82S11	Signetics
			OC	5	N93415A	Signetics
			TS	5	N93425A	Signetics
		60 nsF		5	93415M	† Fairchild
			TS	5	93425M	† Fairchild
			OC	5	93L415C	Fairchild
			TS	5	93L425C	Fairchild
		65 nsF	OC	5	S82S10	† Signetics
			TS	5	S82S11	† Signetics
		70 nsF	OC	5	93415C	AMD
				5	93L415M	† Fairchild
			TS	5	93L425M	† Fairchild
			OC	5	HM2510	Hitachi
			OC	5	IM55S08C	Intersil
			TS	5	IM55S18C	Intersil
			OC	5	μPB2205-1	NEC
			OC	5	93415C	Raytheon
			TS	5	93425C	Raytheon
				(Cont'd)		

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

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MEMORY—RAMs (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
Static (Cont'd)						
1024 x 1	TTL				(Cont'd)	
		75 nsF	OC	5	93415M	† AMD
			OC	5	IM55S08M	† Intersil
			TS	5	IM55S18M	† Intersil
		75 nsR	OC	5	93415M	† Raytheon
			TS	5	93425M	† Raytheon
		80 nsF	—	5	μPB4505-1	NEC
		85 nsF	—	5	μPB4505-2	NEC
		95 nsF	—	5	μPB4505-3	NEC
		100 nsF	OC	5	SN74S309	TI
			TS	5	SN74S209	TI
1024 x 4	NMOS	200 nsF		5	9130EC	AMD
			TS	5	**4104**	**EMM/Semi (667)**
			TS	5	2114-2	Intel
			TS	5	MK4404	Mostek
			TS	5	NC4104A	Nitron
			TS	5	2614	Signetics
		250 nsF	TS	5	7114-11	Intersil
				5	**MM5255**	**National (774)**
				5	**MM5256**	**National (774)**
		300 nsF		5	91L30CC	AMD
				5	9130CC	AMD
				5	9130CM	† AMD
			TS	5	2114-3	Intel
			TS	5	2114L-3	Intel
			TS	5	7114-12	Intersil
		400 nsF		5	91L30BC	AMD
				5	9130BC	AMD
				5	9130BM	† AMD
			TS	5	7114-13	Intersil
		450 nsF	TS	5	**4804A**	**EMM/Semi (663)**
			TS	5	3445	Fairchild
			TS	5	MB8102	Fujitsu
			TS	5	2114	Intel
			TS	5	2114L	Intel
		500 nsF		5	91L30DC	AMD
				5	9130DC	AMD
				5	9130DM	† AMD
			TS	5	7114-14	Intersil
2084 x 1	NMOS	60 nsF		-3,15,7	7003-12	Intersil
4096 x 1	NMOS	100 nsF		-5,12	4402B	EMM/Semi
				±5,12	μPD410-2	NEC
		150 nsF	TS	±5,12	4200B	EMM/Semi
			TS	±5,12	μPD410-1	NEC
			TS	±5,12	NC4402A	Nitron
		200 nsF	TS	5	MK4104	Mostek
			TS	±5,12	μPD410	NEC
			TS	5	9140EC	AMD
			TS	±5,12	**4200A**	**EMM/Semi (671)**
			TS	-5,12	4402A	EMM/Semi
			TS	-5,12	RA3-4402	GI
			TS	±5,12 (Cont'd)	RA3-4200	GI

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
Static (Cont'd)						
4096 x 1	NMOS	200 nsF			(Cont'd)	
			TS	-5,12	4200A	Nitron
			TS	±5,12	4402A	Nitron
			TS	5	2316	Signetics
		250 nsF	TS	5	7141-11	Intersil
			TS	5	**MM5257**	**National (774)**
		300 nsF		5	91L40CC	AMD
				5	9140CC	AMD
			TS	5	7141-12	Intersil
		400 nsF		5	91L40BC	AMD
				5	9140BC	AMD
			TS	5	7141-13	Intersil
		450 nsF	TS	5	4801A	EMM/Semi
		500 nsF		5	91L40DC	AMD
				5	9140DC	AMD
			TS	5	7141-14	Intersil
	TTL	55 nsF	OC	5	93470C	† Fairchild
			TS	5	93471C	Fairchild
			OC	5	93470M	† Fairchild
			TS	5	93471M	Fairchild

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

MEMORY—ROMs

Dynamic

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
256 x 1	PMOS	550 nsF		-12,5	TMS2300	TI
512 x 10		450 nsF	TS	-12,5	**S8771**	**AMI (634)**
1024 x 5	PMOS	450 nsF	TS	-12.5	**S8771**	**AMI (634)**
		500 nsF	TS	-12,5	TMS4200	TI
			TS	±5	MCS2023	MOS
1024 x 1 2	PMOS	3.6 µsF		-12,-24	EA3800	EA
2048 x 4	PMOS	1.3 µsF	TS	-12,5	**S8865**	**AMI (634)**
		1.6 µsF		-12,5	RO5-8192	GI
2048 x 8	PMOS	450 nsF		-12,5	MCS2026	MOS
		1.8 µsF	TS	-12,5	**S9996**	**AMI (634)**
4096 x 4	PMOS	1.8 µsF	TS	-12,5	**S8996**	**AMI (634)**

Static

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
32 X 8						
	TTL	45 nsR	OC	5	SN5488A	† TI
			OC	5	SN7488A	TI
		50 nsF	OC	5	6230-1	MMI
			TS	5	6231-1	MMI
			OC	5	**DM7488**	**National (702)**
			TS	5	**DM8598**	**National (702)**
		50 nsR	OC	5	MCM4002L	† Motorola
			OC	5	MCM4002P	Motorola
		70 nsF	TS	5	**DM7598**	**National (702)**
			OC	5	**DM5488**	**† National (702)**
64 x 8	TTL	75 nsR		5	MCM4003A	Motorola
				5	MCM4303A	† Motorola
	PMOS	650 nsR		±12	MM4220	† National
				±12	MM5220	National
		950 nsR		-12,5	MM4221	† National
				-12,5	MM5221	National
128 x 8	PMOS	1 µsR		-12,5	RO6-1024-8	† GI
				-12,5	RO7-1024-8	GI
		4 µsR		-13,-27	MM3501	National
256 x 4	CMOS	1.8 µsR		3-15	MCM14524A	† Motorola
				3-15	MCM14524C	Motorola
	PMOS	650 nsR		±12	MM4210	† National
				±12	MM4220	† National
				±12	MM5210	National
				±12	MM5220	National
		950 nsR		-12,5	MM4211	† National
				-12,5	MM4221	† National
				-12,5	MM5211	National
				-12,5	MM5221	National
		1 µsR	TS	-12,5	RO6-1024-4	† GI
			TS	-12,5	RO7-1024-4	GI
	TTL	45 nsF	OC	5	93457C	Fairchild
			TS	5	93467C	Fairchild
			OC	5	3301A	Intel
		50 nsF	OC	5	**DM74S187**	**National (702)**
			TS	5	**DM85S97**	**National (702)**
			OC	5	N82S226	Signetics
			TS	5	N82S229	Signetics
				(Cont'd)		

Static (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
256 x 4	TTL				(Cont'd)	
		50 nsR	OC	5	MCM4004A	Motorola
		55 µsF	OC	5	6200-1	MMI
			TS	5	6201-1	MMI
		60 nsF	OC	5	93457M	† Fairchild
			TS	5	93467M	† Fairchild
			OC	5	M3301A	† Intel
			OC	5	**DM54S187**	**† National (702)**
			TS	5	**DM75S97**	**† National (702)**
		60 nsR	OC	5	DM54187	† National
			OC	5	DM74187	National
			TS	5	DM7597	† National
			TS	5	DM8597	National
			OC	5	SN54187	† TI
			OC	5	SN74187	TI
		75 nsF	OC	5	5200-1	† MMI
			TS	5	5201-1	† MMI
			OC	5	S82S226	† Signetics
			TS	5	S82S229	† Signetics
		90 nsF	OC	5	M3301A	† Intel
		130 nsR	TS	5	DM76L97	† National
			TS	5	DM86L97	National
256 x 8	NMOS	450 nsF		5,12	µPD464	NEC
	PMOS	750 nsR		±12	MM4230	† National
				±12	MM5230	National
		850 nsR		-12,5	MM4213	† National
				-12,5	MM5213	National
		950 nsR		-12,5	MM4231	† National
				-12,5	MM5231	National
		1 µsF	TS	-9,5	1302	Intel
		1 µsR	TS	-12,5	MM4252	National
			TS	-12,5	MM5253	National
		1.5 µsR	TS	-12.5	RO5-1302	GI
			TS	-12,5	RO5-1302	GI
			TS	-12,5	RO6-2048-8	† GI
			TS	-12,5	RO7-2048-8	GI
	TTL	60 nsF	OC	5	**DM87S201**	**National (733)**
			TS	5	**DM87S202**	**National (733)**
			OC	5	**DM74S271**	**National (731)**
			TS	5	**DM74S371**	**National (731)**
			TS	5	N82S214	Signetics
		65 nsF	OC	5	6208-1	MMI
			TS	5	6209-1	MMI
		70 nsF	OC	5	SN74S271	TI
			TS	5	SN74S371	TI
		75 nsF	OC	5	**DM77S201**	**† National (733)**
			TS	5	**DM77S202**	**† National (733)**
			OC	5	**DM54S271**	**† National (731)**
			TS	5	**DM54S371**	**† National (731)**
		85 nsF	OC	5	5208-1	† MMI
				(Cont'd)		

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

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MEMORY—ROMs (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
Static (Cont'd)						
256 x 8	TTL	85 nsF			(Cont'd)	
			TS	5	5209-1	† MMI
		90 nsF	OC	5	6235-1	MMI
			TS	5	6236-1	MMI
			TS	5	S82S214	† Signetics
		95 nsF	OC	5	SN54S271	† TI
			TS	5	SN54S371	† TI
		120 nsF	OC	5	5235-1	† MMI
			TS	5	5236-1	MMI
		180 nsR	OC	5	DM54L187A	† National
			OC	5	DM74L187A	National
256 x 10	PMOS	600 nsF		-12,5	MK2400	Mostek
256 x 12	PMOS	1.4 µsF		-12,5	MM4229	† National
				-12,5	MM5229	National
320 x 7	PMOS	700 nsR		-14,-28	MK2000	Mostek
		1 µsF		-12,5	MK2300	Mostek
384 x 8	PMOS	900 nsR		-12,5	MM4241	† National
				-12,5	MM5251	National
512 x 4	PMOS	725 nsR		±12	MM5230	National
				±12	MM4230	† National
		850 nsR	TS	-12,5	MM4213	† National
			TS	-12,5	MM5213	National
		950 nsR		-12,5	MM4231	† National
				-12,5	MM5231	National
		1 µsR	TS	-12,5	**MM4243**	**National (834)**
			TS	-12,5	MM5253	National
		1.5 µsR		-12,5	RO6-2048-4	† GI
				-12,5	RO7-2048-4	GI
	TTL	50 nsF	OC	5	93431C	Fairchild
			TS	5	93441C	Fairchild
			OC	5	N82S230	Signetics
			TS	5	N82S231	Signetics
		55 nsF	OC	5	**DM74S270**	**National (729)**
			TS	5	**DM74S370**	**National (729)**
		60 nsF	OC	5	93431M	† Fairchild
			TS	5	93441M	† Fairchild
			OC	5	6205-1	MMI
			TS	5	6206-1	MMI
		70 nsF	OC	5	3302A	Intel
			TS	5	3322A	Intel
			OC	5	**DM54S270**	**† National (729)**
			TS	5	**DM54S370**	**† National (729)**
			OC	5	S82S230	Signetics
			OC	5	SN74S270	TI
			TS	5	SN74S370	TI
		75 nsR	OC	5	5205-1	† MMI
			TS	5	5206-1	† MMI
		90 nsF	OC	5	3302A-4	Intel
			OC	5	3302AL-6	Intel
			TS	5	3322A-4	Intel
			TS	5	3322AL-4	Intel
					(Cont'd)	

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
Static (Cont'd)						
512 x 4	TTL				(Cont'd)	
		95 nsF	OC	5	SN54S270	† TI
			TS	5	SN54S370	† TI
512 x 5	NMOS	450 nsF	TS	5	RO3-2560	EMM/Semi
			TS	5	RO3-2560	GI
	PMOS	500 nsR		±12	MM4240	† National
				±12	MM5240	National
512 x 8	CMOS	400 ns	TS	10	CDP1832	† RCA
		850 ns	TS	5	CDP1832C	RCA
	NMOS	500 nsF	TS	5	9214C	AMD
			TS	5	9214M	† AMD
			TS	5	RO3-4096	EMM/Semi
			TS	5	RO3-4096	GI
			TS	5	MM5238	National
			TS	5	SY3514	Synertek
			TS	5	SY5232	Synertek
			TS	5	SY2530	Synertek
	PMOS	600 nsF	TS	-12,5	351519	Fairchild
			TS	-12,5	3515192	Fairchild
		700 nsF	TS	-12,5	ITT3514-1	ITT
			TS	-12,5	MK2500	Mostek
			TS	-12,5	MK2600	Mostek
			TS	-12,5	2530	Signetics
		850 nsF	TS	-12,5	3514191	Fairchild
		1 µsF	TS	-12,5	**S3514**	**AMI (650)**
			TS	-12,5	**S5232**	**AMI (650)**
			TS	-12,5	3514192	Fairchild
			TS	-12,5	ITT3514-2	ITT
			TS	-9,5	**MM1742**	**National (827)**
			TS	-12,5	**MM5244**	**National (836)**
		1 µsR	TS	-12,5	MM4214	† National
			TS	-12,5	MM4232	† National
			TS	-12,5	MM4233	† National
			TS	-12,5	MM5214	National
			TS	-12,5	MM5232	National
			TS	-12,5	MM5233	National
		1.25 µsF	TS	-12,5	**MM4244**	**National (836)**
	TTL	55 nsF	OC	5	93432C	Fairchild
			TS	5	93442C	Fairchild
		60 nsF	TS	5	N82S215	Signetics
		65 nsF	OC	5	62481	MMI
			TS	5	6249-1	MMI
			OC	5	**DM87S95**	**National (735)**
			TS	5	**DM87S96**	**National (735)**
		70 nsF	OC	5	93432M	† Fairchild
			TS	5	93442M	† Fairchild
			OC	5	3304A	Intel
			TS	5	3324A	Intel
		75 nsR	OC	5	3304AL-6	Intel
		80 nsF	OC	5	**DM77S95**	**† National (735)**
			TS	5	**DM77S96**	**† National (735)**
		85 nsF	OC	K	5248-1	† MMI
			TS	5	5249-1	MMI
		90 nsF	TS	5	3304A-4	Intel
					(Cont'd)	

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

MEMORY—ROMs (Cont'd)

Static (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
512 x 8	TTL	90 nsF			(Cont'd)	
			TS	5	3324A-4	Intel
			OC	5	6240-1	MMI
			TS	5	6241-1	MMI
			TS	5	S82S215	† Signetics
		120 nsF	OC	5	5240-1	† MMI
			TS	5	5241-1	† MMI
			OC	5	DM8595	National
			TS	5	DM8596	National
			OC	5	DM8795	National
			TS	5	DM8796	National
		150 nsF	OC	5	AM27S40	AMD
			TS	5	AM27S41	AMD
			OC	5	DM7595	† National
		150 nsR	TS	5	DM7596	† National
			OC	5	DM7795	† National
			TS	5	DM7796	† National
		180 nsF	OC	5	AM27S40M	† AMD
			TS	5	AM27S41M	† AMD
512 x 10	NMOS	500 nsF	TS	5	RO3-5120	EMM/Semi
			TS	5	RO3-5120	GI
	PMOS	725 nsF		±12	EA4000	EA
1024 x 4	PMOS	700 nsF	TS	-12,5	MK2500	Mostek
			TS	-12,5	MK2600	Mostek
		1 μsF	TS	-12,5	**S5232**	**AMI (650)**
		1 μsR	TS	-12,5	MM4232	† National
			TS	-12,5	MM5232	National
	TTL	60 nsF	OC	5	6250-1	MMI
			TS	5	6251-1	MMI
			OC	5	6252-1	MMI
			TS	5	6253-1	MMI
		70 nsF		5	N8228	Signetics
		75 nsF	OC	5	5250-1	† MMI
			TS	5	5251-1	† MMI
			OC	5	5252-1	† MMI
			TS	5	5253-1	† MMI
1024 x 8	NMOS	250 nsF	TS	5,12	9208DC	AMD
		290 nsF	TS	±5,12	NC6560A	Nitron
		300 nsF	TS	5,12	9208CC	AMD
		350 nsF	TS	5	EA4700	EA
			TS	-3,5,12	MCM6560	Motorola
			TS	-3,5,12	NC6560	Nitron
		400 nsF	TS	5,12	9208BC	AMD
			TS	5	EA2308A	EA
			TS	5	EA4700-1	EA
			TS	5	EA8308A	EA
		450 nsF	TS	±5,12	3508	Fairchild
			TS	±5,12	MS8308	Fujitsu
			TS	5	2607	Signetics
			TS	5	12605-10	Intersil
			TS	5,12	MK30000-3	Mostek
				(Cont'd)		

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
Static (Cont'd)						
1024 x 8	NMOS	450 nsF			(Cont'd)	
			TS	5	**MM5242**	**National (832)**
			TS	±5,12	μPD2308	NEC
			TS	5	2607	Signetics
			TS	±5,12	**TMS4700**	**TI (856)**
		475 nsF	TS	±5,12	μPD465	NEC
		500 nsF	TS	5	EA2308AM	† EA
			TS	±5,12	2308	Intel
			TS	5	MCM6830A	Motorola
		550 nsF	TS	5	EA4700M	† EA
			TS	5	2608-11	Intersil
			TS	5	2608	Signetics
		575 nsF	TS	5	**S6830**	**AMI (889,659,925)**
			TS	5	MCM6830	Motorola
			TS	5	**MM4242**	**† National (832)**
		600 nsF	TS	5,12	9208M	† AMD
			TS	5	2608-12	Intersil
	TTL	45 nsF	OC	5	93454C	Fairchild
			TS	5	93464C	Fairchild
		60 nsF	OC	5	93454M	† Fairchild
			TS	5	93464M	† Fairchild
		70 nsF	OC	5	**DM85S29**	**National (737)**
			TS	5	**DM85S28**	**National (737)**
		90 nsF	OC	5	IM53S08C	Intersil
			TS	5	IM53S18C	Intersil
			OC	5	6280-1	MMI
			TS	5	6281-1	MMI
			OC	5	6284-1	MMI
			TS	5	6285-1	MMI
			OC	5	6286-1	MMI
			TS	5	6887-1	MMI
			OC	5	**DM75S29**	**† National (737)**
			TS	5	**DM75S28**	**† National (737)**
		100 nsF	OC	5	IM53S08M	† Intersil
			TS	5	IM53S18M	† Intersil
		125 nsF	OC	5	5280-1	† MMI
			TS	5	5281-1	† MMI
			OC	5	5284-1	† MMI
			TS	5	5285-1	† MMI
			OC	5	5286-1	† MMI
			TS	5	5287-1	† MMI
			OC	5	N82S280	Signetics
			TS	5	N82S281	Signetics
		175 nsF	OC	5	AM27S80C	AMD
			TS	5	AM27S81C	AMD
		275 nsF	OC	5	AM27S80M	† AMD
			TS	5	AM27S81M	† AMD
1024 x 9	TTL	90 nsF	OC	5	IM53S09C	Intersil
			TS	5	IM53S19C	Intersil
		100 nsF	OC	5	IM53S09M	† Intersil
				(Cont'd)		

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

Bold face indicates additional data is provided on the page noted.

MEMORY—ROMs (Cont'd)

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
Static (Cont'd)						
1024 x 9	TTL	100 nsF			(Cont'd)	
			TS	5	IM53S19M	† Intersil
		150 nsF	OC	5	5260	† MMI
			OC	5	6260	MMI
			TS	5	5261	† MMI
			TS	5	6261	MMI
1024 x 10	TTL	90 nsF	OC	5	IM53S10C	Intersil
			TS	5	IM53S20C	Intersil
			OC	5	IM53S10M	† Intersil
			TS	5	IM53S20M	† Intersil
		150 nsR	OC	5	5255	† MMI
			OC	5	6255	MMI
			TS	5	5286	MMI
			TS	5	6286	MMI
1024 x 12	CMOS	200 ns	TS	10	IM6312	Intersil
		250 nsR	TS	4-11	**HM6312A-2**	† **Harris (681)**
			TS	4-11	**HM6312A-9**	**Harris (681)**
		500 nsR	TS	5	**HM6312-2**	† **Harris (681)**
			TS	5	**HM6312-9**	**Harris (681)**
		500 ns	TS	5	IM6312	Intersil
	PMOS	3 μsR		±12	MM5215	National
		5 μsR		-12,5	MM5212	National
2048 x 4	NMOS	290 nsF	TS	±5,12	NC6560A	Nitron
		350 nsF	TS	-3,5,12	MCM6560	Motorola
			TS	-3,5,12	NC6560	Nitron
		450 nsF	TS	5	**MM5245**	**National (832)**
		550 nsF	TS	5	**MM4245**	† **National (832)**
	PMOS	450 nsF	TS	-12,5	RO1492C	Western
		950 nsR		-12,5	2580	Signetics
2048 x 8	NMOS	300 nsF	TS	5,12	9216CC	AMD
			TS	5	2600-1	Signetics
		350 nsF	TS	5	MK34000-3	Mostek
		400 nsF	TS	5	9216BC	AMD
		450 nsF	TS	5	S8316	AMI
			TS	5	RO3-8316B	EMM/Semi
			TS	5	RO3-8316B	GI
			TS	5	RO3-9316B	GI
			TS	5	**MM5246**	**National (838)**
			TS	5	μPD2316	NEC
			TS	5	2616-11	Intersil
			TS	5	**MM2316A**	**National (830)**
			TS	5	μPD2316A-1	NEC
			TS	5	2616	Signetics
			TS	5	2617	Signetics
			TS	5	SY2316B	Synertek
			TS	5	SY8316B	Synertek
		475 nsF	TS	±5,12	μPD466	NEC
			TS	±5,12	NC6590A	Nitron
		500 nsF	TS	5	**S6831**	**AMI (889,660,927)**
			TS	±5,12	MCM65317	Motorola
			TS	5	MCM68316E	Motorola
			TS	5 (Cont'd)	**MM5246**	**National (838)**

Organization	Type	Access Time (Max)	Output	Supply Voltage	Device	Source
Static (Cont'd)						
2048 x 8	NMOS				(Cont'd)	
		550 nsF	TS	-5	EA4600C	EA
			TS	5	MK31000-3	Mostek
			TS	±5,12	MCM6832	Motorola
			TS	±5,12	NC6832	Nitron
			TS	5	2600	Signetics
			TS	5	SY2316A	Synertek
			TS	5	SY4600	Synertek
			TS	5	SY8316A	Synertek
		575 nsF	TS	5	**MM4246**	† **National (838)**
		750 nsF	TS	5	EA4600M	† EA
		800 nsF	TS	-3,5,12	MCM6590	Motorola
			TS	-3,5,12	NC6590	Nitron
		850 nsF	TS	5	RO3-8316A	EMM/Semi
			TS	5	RO3-8316A	GI
			TS	5	RO3-9316A	GI
			TS	5	2316A	Intel
			TS	5	μPD2316A	NEC
	PMOS	600 nsF		-12,5	MK28000	Mostek
		700 nsF		-12,5	TMS4800	TI
		950 nsF		-12,5	EA4900C	EA
		1.35 μsF		-12,5	EA4900L	EA
	TTL	110 nsF	OC	5	6275	MMI
			TS	5	6276	MMI
		125 nsF	OC	5	N82S290	Signetics
		120 nsF	OC	5	5275	† MMI
			TS	5	5276	† MMI
			TS	5	N82S291	Signetics
2048 x 10	NMOS	500 nsF	TS	5	RO3-20480	GI
4096 x 4	NMOS	450 nsF	TS	5	2617	Signetics
			TS	5	**MM5247**	**National (838)**
		550 nsF	TS	5	EA4600C	EA
			TS	5	SY4600	Synertek
		575 nsF	TS	5	**MM4247**	† **National (838)**
		750 nsF	TS	5	EA4600M	† EA
		1 μsF	TS	5	RO3-16384	EMM/Semi
			TS	5	RO3-16384	GI
	PMOS	600 nsF		-12,5	MK28000	Mostek
		700 nsF		±12,5	TMS4800	TI
		950 nsF		-12,5	EA4900	EA
4096 x 8	NMOS	550 nsF	TS	5	MK3200	Mostek

† Military Temperature Range (−55°C to 125°C) ns—Nanoseconds Typical nsF—Nanoseconds over Full Temperature Range nsR—Nanoseconds at Room Temperature
OC—Open Collector TS—Three-State OE—Open Emitter

MEMORY—Shift Registers

Dynamic

Bits Per Register	No of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
16	4	SS	PMOS	3.0 M	-28	EA1208	EA
32	4	SS	PMOS	1.0 M	-28	EA1201	EA
				3.0 M	-28	EA1200	EA
64	1	SS	PMOS	1.0 M	-14,-28	EA1203	EA
				3.0 M	-14,-28	EA1202	EA
	2	SS	PMOS	0.1 M	-14	HD3213	Hitachi
					-14,9	HD3214	Hitachi
	3	SS	PMOS	0.1 M	-14	HD3214	Hitachi
	4	SS	PMOS	3.0 M	-12,5	MP3417	Plessey
				5.0 M	-12,5	TMS3417	TI
					±5	HD3508	Hitachi
66	3	SS	PMOS	1.0 M	-14	CRC1505	Collins
				2.0 M	-24,-14	MTS1016	MOS
72	3	SS	PMOS	5.0 M	±5	HD3523	Hitachi
					±5	HD3524	Hitachi
80	4	SS	PMOS	2.5 M	-12,5	IM7780C	Intersil
					-12,5	MK1007	Mostek
					-12,5	SY7780	Synertek
				3.0 M	-12,5	MP3409	Plessey
				5.0 M	-12,5	TMS3409	TI
100	2	SS	PMOS	1.0 M	±5	HD3506	Hitachi
					±5	HD3507	Hitachi
				2.0 M	-10	MTS1001	MOS
					±5	1406	† AMD
					±5	1407	† AMD
					±5	1506	AMD
					±5	1507	AMD
				2.5 M	-12,5	MM4006	† National
					-12,5	MM5006	National
				3.0 M	±5	MTS2013	MOS
					±5	2506	Signetics
					±5	2507	Signetics
					±5	2517	Signetics
128	2	SS	PMOS	5.0 M	±5	HD3509	Hitachi
200	1	SS	CMOS	5.0 M	3-15	CD4062A	† RCA
			PMOS	1.0 M	-28	EA1221	EA
256	1	SS	PMOS	1.0 M	-28	EA1205	EA
				2.0 M	-12,5	3383	Fairchild
				2.5 M	±5	HD3510	Hitachi
				3.0 M	-14	EA1204	EA
	2	SS	PMOS	2.5 M	-14	EA1210	EA
	4	SS	PMOS	2.5 M	±5	SY1402B	Synertek
					±5	SY1402BR	Synertek
				3.0 M	±5	HDSR1026	Hughes
				5.0 M	±5	1402AC	AMD
					±5	1402AM	† AMD
					±5	HD3502	Hitachi
					±5	1402A	Intel
					±5	MM1402A	National
					±5	1402	Nortec
					±5	1402A	Nortec
					±5	M141	SGS
					±5	SY1402A	Synertek
					±5	SY1402AR	Synertek

(Cont'd)

Dynamic (Cont'd)

Bits Per Register	No of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
256	4	SS	PMOS			(Cont'd)	
				8.0 M	±5	2502	Signetics
				10.0 M	±5	AM2802C	AMD
					±5	AM2802M	† AMD
					±5	SY2802	Synertek
	64	SS	CCD	1.0 M	-5,12	2416	Intel
360	2	SS	PMOS	2.5 M	-12,5	MM4104	† National
					-12,5	MM5104	National
480	1	SS	PMOS	2.0 M	-12,5	ITT3330	ITT
500	1	SS	PMOS	2.0 M	-12,5	ITT3331	ITT
512	1	SS	PMOS	2.0 M	±5	1405A	Intel
					-12,5	ITT3329	ITT
				2.5 M	±5	2505	Signetics
					-12,5	MM4016	† National
					-12,5	MM5016	National
				3.0 M	±5	AM2805M	† AMD
					±5	AM2807M	† AMD
					±5	2524	Signetics
					-14	EA1212	EA
				4.0 M	±5	AM2805C	AMD
					±5	AM2807C	AMD
				5.0 M	±5	HD3505	Hitachi
					±5	MTS2100	MOS
					-12,5	TMS3401	TI
					-27	EA1206	EA
	2	SS	PMOS	2.5 M	±5	SY1403B	Synertek
					±5	SY1403BR	Synertek
				5.0 M	±5	1403AC	AMD
					±5	1403AM	† AMD
					±5	HD3503	Hitachi
					±5	1403A	Intel
					±5	MM1403A	National
					±5	1403A	Nortec
					±5	M136	SGS
					±5	SY1403A	Synertek
					±5	SY1403AR	Synertek
				8.0M	±5	HDSR1025	Hughes
					±5	2503	Signetics
				10.0 M	±5	AM2803C	AMD
					±5	AM2803M	† AMD
					±5	SY2803	Synertek
1024	1	SS	NMOS	1.0 M	5	2405	Intel
					5	SY2405	Synertek
			PMOS	2.5 M	±5	2512	Signetics
					±5	2525	Signetics
					±5	SY1404B	Synertek
					±5	SY1404BR	Synertek
				3.0 M	±5	AM2806M	† AMD
					±5	AM2808M	† AMD
					±5	IM7712	Intersil
					±5	IM7722	Intersil
					±5	2512	Nortec
				4.0 M	±5	AM2806C	AMD
					±5	AM2808M	AMD
					±5	2512	Nortec
					±5	SY7712	Synertek
					±5	SY7722	Synertek
				5.0 M	±5	1404AC	AMD

(Cont'd)

† Military Temperature Range (−55°C to 125°C) SS = Serial In, Serial Out PP = Parrallel In, Parallel Out

Bold face indicates additional data is provided on the page noted.

MEMORY—Shift Registers (Cont'd)

Bits Per Register	No of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
Dynamic (Cont'd)							
1024	1		PMOS	5.0 M		(Cont'd)	
					±5	1404AM	† AMD
					±5	HD3504	Hitachi
					±5	1404A	Intel
					±5	MM1404A	National
					±5	MM5024A	National
					±5	1404A	Nortec
					5	SY1404A	Synertek
					5	SY1404AR	Synertek
				8.0 M	±5	HDSR1024	Hughes
					±5	2504	Signetics
					±5	M130	SGS
				10.0 M	±5	AM2804C	AMD
					±5	AM2804M	† AMD
					±5	SY2804	Synertek
	2	SS	NMOS	1.0 M	5	AM2401	AMD
					5	2401	Intel
					5	SY2401	Synertek
				2.0 M	5	9401C	AMD
					5	9401M	† AMD
				2.5 M	5	SY2401-1	Synertek
			PMOS	1.0 M	-12,5	MM4025	† National
					-12,5	MM4026	† National
				3.0 M	-12,5	MM5025	National
					-12,5	MM5026	National
					-12,5	SY5025	Synertek
					-12,5	SY5026	Synertek
				4.0 M	-10.5,5	AM2825M	† AMD
					-10.5,5	AM2826M	† AMD
				6.0 M	-10.5,5	AM2825C	AMD
					-10.5,5	AM2826C	AMD
					-10.5,5	SY2825A	Synertek
					-10.5,5	SY2826A	Synertek
				8.0 M	±5	HDSR2048	Hughes
	9	SS	CCD	2.0 M	-2.5,5,12	CCD450A	Fairchild
				1.0 M	-2.5,5,12	CCD450	Fairchild
				2.0 M	-2.5,5,12	CCD450A	Fairchild
					-2.5,5,12	CCD451	Fairchild
				4.0	-2.5,5,12	CCD451A	Fairchild
2048	1	SS	PMOS	1.0 M	-12,5	MM4027	† National
				3.0 M	-12,5	MM5027	National
					-12,5	SY5027	Synertek
				4.0 M	-10.5,5	AM2827M	† AMD
					-12,5	SY5028	Synertek
				6.0 M	-10.5,5	AM2827C	AMD
					-10.5,5	SY2827	Synertek
4096	4	PP	CCD	2.0 M	-5,12	2444	Intel
				5.0 M	±5,12	CCD460	Fairchild
Static							
4	1	PP	Bipolar	3 M	5	SN54L95	TI
					5	SN54L99	† TI
					5	SN74L95	TI
					5	SN74L99	TI
				5 M	5	93L00C	† AMD
					5	93L00M	† AMD
					(Cont'd)		

Bits Per Register	No of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
Static (Cont'd)							
4	1	PP	Bipolar			(Cont'd)	
				6 M	5	DM54L95	† National
					5	DM74L95	National
				15 M	5	9300C	AMD
					5	9300M	† AMD
					5	93L00C	† Fairchild
					5	93L00M	† Fairchild
					5	ITT9300-1	† ITT
					5	ITT9300-5	ITT
					5	MC8300	Motorola
					5	MC9300	† Motorola
					5	RC9300	Raytheon
					5	RM9300	† Raytheon
					5	N8270	Signetics
					5	N8271	Signetics
				20 M	5	HD2534	Hitachi
					5	MC7270	Motorola
					5	MC7271	Motorola
					5	MC8270	Motorola
					5	MC8271	Motorola
					5	DM54LS295A	† National
					5	DM74LS295A	National
					5	DM5495	† National
					5	DM7495	National
					5	RC8270	Raytheon
					5	RC8271	Raytheon
					5	RM8270	† Raytheon
					5	RM8271	† Raytheon
					5	SW5495	† SW
					5	SW7495	SW
				25 M	5	SN54194	† AMD
					5	SN74194	AMD
					5	5495	† Fairchild
					5	7495	Fairchild
					5	54178	† Fairchild
					5	54179	† Fairchild
					5	54194	† Fairchild
					5	74178	Fairchild
					5	74179	Fairchild
					5	74194	Fairchild
					5	ITT5495	† ITT
					5	ITT54194	† ITT
					5	ITT7495	ITT
					5	ITT74194	ITT
					5	DM54LS194	† National
					5	DM74LS194	National
					5	54194	† Raytheon
					5	74194	Raytheon
					5	5495	† Signetics
					5	7495	Signetics
					5	74194	Signetics
					5	54194	† Signetics
					5	SN5495A	† TI
					5	SN54178	† TI
					5	SN54179	† TI
					5	SN54194	TI
					5	SN7495A	TI
					5	SN74178	TI
					5	SN74179	TI
					5	SN74194	TI
				30 M	5	SN54195	† AMD
					5	SN74195	AMD
					5	54LS95	† Fairchild
					5	74LS95	Fairchild
					5	5495	† Fairchild
					(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

SS = Serial In, Serial Out

PP = Parrallel In, Parallel Out

MEMORY—Shift Registers (Cont'd)

Static (Cont'd)

Bits Per Register	No of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
4	1	PP	Bipolar	30 M		(Cont'd)	
					5	7495	Fairchild
					5	54LS194	Fairchild
					5	74LS194	Fairchild
					5	54LS195	† Fairchild
					5	74LS195	Fairchild
					5	54LS295	† Fairchild
					5	74LS295	Fairchild
					5	ITT54195	† ITT
					5	ITT74195	ITT
					5	MC54195	† Motorola
					5	MC74195	Motorola
					5	DM5495	† National
					5	DM7495	National
					5	DM54LS95	† National
					5	DM74LS95	National
					5	DM54LS195	† National
					5	DM74LS195	National
					5	DM8300	National
					5	DM9300	† National
					5	54195	† Raytheon
					5	74195	Raytheon
					5	74195	Signetics
					5	54195	† Signetics
					5	SN54195	† TI
					5	SN74195	TI
				31 M	5	MC5495	† Motorola
					5	MC7495	Motorola
				35 M	5	MC4012	Motorola
				38 M	5	9300C	Fairchild
					5	9300M	† Fairchild
				55 M	5	93H00C	† Fairchild
					5	93H00M	† Fairchild
				60 M	5	93H72C	Fairchild
					5	93H72M	† Fairchild
					5	N82S70	Signetics
					5	N82S71	† Signetics
				70 M	5	SN54S194	† AMD
					5	SN54S195	† AMD
					5	SN74S194	AMD
					5	SN74S195	AMD
					5	93S00C	Fairchild
					5	93S00M	† Fairchild
					5	93S194C	Fairchild
					5	93S194M	† Fairchild
					5	DM54S194	† National
					5	DM74S194	National
					5	DM54S195	† National
					5	DM74S195	National
					5	SN54S194	† TI
					5	SN54S195	† TI
					5	SN74S194	TI
					5	SN74S195	TI
				75 M	5	54S194	Signetics
					5	74S194	Signetics
				150 M	-4.5	F10000	Fairchild
					-5.2	MC10141	Motorola
					-5.2	10141	Signetics
				190 M	-5.2	95H00C	Fairchild
				250 M	-5.2	F10141	Fairchild
		PS	Bipolar	1 M	11	MC794	Motorola
				10 M	5	5494	† Fairchild
					5	7494	Fairchild
					(Cont'd)		

Bits Per Register	No of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
4	1	PS	Bipolar	10 M		(Cont'd)	
					5	ITT5494	† ITT
					5	ITT7494	ITT
					5	MC5494	† Motorola
					5	MC7494	Motorola
					5	7494	Signetics
					5	5494	Signetics
					5	SW7494	SW
					5	SN5494	† TI
					5	SN7494	TI
		SP		325 M	-5.2	MC1694	† Motorola
		SS		0.5 M	15	MC686	Motorola
		PP	CMOS	2 M	3-15	F4035BM	† Fairchild
					3-15	F4019BM	† Fairchild
					3-15	F40195BM	† Fairchild
					3-15	HD4035B-9	† Harris
					3-15	MC14035BC	Motorola
					3-15	CD4035BE	RCA
					3-15	SCL4035B	SSS
					3-15	CM4035AE	Solitron
					3-15	TC4035	Toshiba
				3 M	3-15	F4035BC	Fairchild
					3-15	F40194BC	Fairchild
					3-15	F40195BC	Fairchild
					3-15	HD4035B-2	Harris
					3-15	MC14035BA	† Motorola
					3-15	CD4035B	† RCA
					3-15	CM4035A	† Solitron
					3-15	TP4035A/B	TI
				9 M*	3-15	CD40104B	RCA
					3-15	CD40104BE	† RCA
	2	SP	CMOS	1 M	5	CM4015AE	Solitron
				1.5 M	5	CM4015AD	† Solitron
					3-15	TP4015A/B	TI
					3-15	TF4015A/B	† TI
				2.5 M	3-15	34015BC	Fairchild
					3-15	HD4015B-9	Harris
					3-16	MC14015BC	Motorola
					3-15	CD4015AC	National
					3-15	CD4015BE	RCA
					3-15	TC4015	Toshiba
				3 M	3-15	34015BM	† Fairchild
					3-15	HD4015B-2	† Harris
					3-18	MC14015A	† Motorola
					3-15	CD4015AM	† National
					3-15	CD4015B	† RCA
					3-15	SCL4015B	† SSS
					3-15	SCL4015BE	SSS
5	1	PP	Bipolar	10 M	5	5496	† Fairchild
					5	7496	Fairchild
					5	ITT5496	† ITT
					5	ITT7496	ITT
					5	MC5496	† Motorola
					5	MC7496	Motorola
					5	DM5496	† National
					5	DM7496	National
					5	7496	Signetics
					5	5496	† Signetics
					5	SW5496	† SW
					5	SW7496	SW
					5	SN5496	† TI
					5	SN7496	TI
					5	7496	TRW
					(Cont'd)		

† Military Temperature Range (−55°C to 125°C)

SS = Serial In, Serial Out

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Bold face indicates additional data is provided on the page noted.

MEMORY—Shift Registers (Cont'd)

Bits Per Register	No of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
Static (Cont'd)							
5	1					(Cont'd)	
		PP	Bipolar	35 M	5	HD2546	Hitachi
	4	SS	CMOS	1.2 M	5	CM4006AE	Solitron
				1.5 M	5	CM4006AD	† Solitron
				2 M	3-15	CM4006A	† Solitron
					3-15	CM4006AE	Solitron
					3-15	CD4006AE	RCA
				2.5 M	3-15	CD4006A	† RCA
				3 M	3-15	SCL4006A	† SSS
					3-15	SCL4006A	SSS
				4 M	5-15	MC14006BC	Motorola
				7 M	5-15	MC14006BA	† Motorola
8	1	PP	Bipolar		5	54198	† Fairchild
					5	54199	† Fairchild
					5	74198	Fairchild
					5	74199	Fairchild
					5	DM54198	† National
					5	DM54199	† National
					5	DM74198	National
					5	DM74199	National
					5	54198	† Raytheon
					5	54199	† Raytheon
					5	74198	Raytheon
					5	74199	Raytheon
					5	74198	Signetics
					5	74199	Signetics
					5	54198	† Signetics
					5	54199	† Signetics
					5	SN54198	† TI
					5	SN54199	† TI
					5	SN74198	TI
					5	SN74199	† TI
				70 M	5	SN74S299	TI
		PS	Bipolar	14 M	5	DM7590	† National
					5	DM8590	National
				20 M	5	54165	† Fairchild
					5	74165	Fairchild
					5	54165	† Raytheon
					5	74165	Raytheon
					5	54165	† Signetics
					5	74165	Signetics
					5	SN54165	† TI
					5	SN74165	TI
				25 M	5	54166	† Fairchild
					5	74166	Fairchild
					5	DM54166	† National
					5	DM74166	National
					5	54166	† Raytheon
					5	74166	Raytheon
					5	54166	† Signetics
					5	74166	Signetics
					5	SN54166	† TI
					5	SN74166	TI
		SP	Bipolar	12 M	5	DM54L164	† National
					5	DM74L164	National
					5	SN54L164	† TI
					5	SN74L164	TI
				14 M	5	MC54164A	† Motorola
					5	MC74164A	Motorola
					5	DM7570	† National
					5	DM8570	National
					(Cont'd)		

Bits Per Register	No of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
Static (Cont'd)							
8	1	SP	Bipolar			(Cont'd)	
				25 M	5	54164	† Fairchild
					5	74164	Fairchild
					5	54LS164	† Fairchild
					5	74LS164	Fairchild
					5	DM54LS164	† National
					5	DM74LS164	National
					5	54164	† Raytheon
					5	74164	Raytheon
					5	74164	Signetics
					5	54164	† Signetics
		SS	Bipolar	3 M	5	SN54L91	† TI
					5	SN74L91	TI
				4 M	5	DM54L91	† National
					5	DM74L91	National
				10 M	5	5491	† Fairchild
					5	7491	Fairchild
					5	HD2524	Hitachi
					5	MC5491A	† Motorola
					5	MC7491A	Motorola
					5	7491	Signetics
					5	5491	† Signetics
					5	SW5491A	† SW
					5	SW7491A	SW
					5	SN5491A	† TI
					5	SN7491A	TI
				15 M	5	N8276	Signetics
		PP	CMOS	2.5 M	3-18	MC14034BC	Motorola
					3-15	SCL4034BE	SSS
					5	CM4034AE	Solitron
				3 M	3-18	MC14034B	Motorola
					3-15	CD4039BM	National
					3-15	CD4034B	† RCA
					3-15	SCL4034B	† SSS
					5	CM4034A	† Solitron
					3-15	TC4034	Toshiba
		PS	CMOS	1 M	3-15	F4014BC	Fairchild
					3-15	F4021CBC	Fairchild
					3-15	CM4014A	† Solitron
				1.3 M	3-45	TP4021A/B	TI
				1.8 M	3-15	TF4021A/B	† TI
				2.5 M	3-15	HD4014B-9	Harris
					3-15	HD4021B-9	Harris
					3-15	MC14021BC	Motorola
					3-15	CD4014BE	RCA
					3-15	CD4021B	† RCA
					3-15	CD4021BE	RCA
					3-15	TC4014	Toshiba
					3-15	TC4021	Toshiba
				3 M	3-15	F4014BM	† Fairchild
					3-15	F4021BM	† Fairchild
					3-15	HD4014B-2	Harris
					3-15	HD4021B-2	† Harris
					3-15	MC14021B	† Motorola
					3-15	CD4014B	† RCA
					3-15	CD4021B	† RCA
					3-15	SCL4014B	† SSS
					3-15	SCL4021B	† SSS
					3-15	CM4021A	† Solitron
	2	SS	Bipolar	10 M	5	93L28C	AMD
					5	93L28M	† AMD
					5	93L28M	† Fairchild
					(Cont'd)		

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MEMORY—Shift Registers (Cont'd)

Bits Per Register	No of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
Static (Cont'd)							
8	2	SS	Bipolar	10 M		(Cont'd)	
					5	93L28C	Fairchild
					5	MC8328	Motorola
					5	MC9328	† Motorola
				15 M	5	RC8277	Raytheon
					5	RM8277	† Raytheon
					5	N8277	Signetics
				20 M	5	9328C	AMD
					5	9328M	† AMD
					5	9328C	Fairchild
					5	9328M	† Fairchild
10	1	PP	TTL	0.5 M	5	RC8274	Raytheon
					5	RM8274	† Raytheon
					5	N8274	Signetics
					5	S8274	† Signetics
		SP	PMOS	0.5 M	5	RC8273	Raytheon
					5	RM8273	† Raytheon
					5	N8273	Signetics
					5	S8273	† Signetics
	2	SS	CMOS	2 M	5-10	HSSR0321	Hughes
						HSSR0351	Hughes
16	2	SS	PMOS	2 M	-12,5	SS5-8211	GI
					-12,5	SS5-8212	GI
					-12,5	SS6-8211	† GI
					-12,5	SS6-8212	† GI
	4	SS	PMOS	2 M	-12,5	SL5-4016	GI
	8	SS	MNOS	0.5 M	-30	NC7030	Nitron
20	1	SP	PMOS	5 K	-14,9	HD32112	Hitachi
24	4	SS	CMOS	2.5 M	5-16	MS618	† Ragen
25	4	SS	PMOS	1 M	-12,5	SL5-4025	GI
					-12,5	SL6-4025	† GI
				2 M	-12,5	MCS2104	† MOS
32	1	SS	PMOS	1 M	-12,5	SS5-1032	GI
					-12,5	SS6-1032	† GI
	2	SS	PMOS	1 M	-16,-10	MTS1002	MOS
				1.5 M	-28	EA1003	EA
					-28	EA1007	EA
				2 M	-12,5	MTS2103	† MOS
	4	SS	PMOS	1 M	-12,5	SL5-4032	GI
					-12,5	SL6-4032	† GI
	6	SS	PMOS	1 M	-12,5	3348	Fairchild
					-12,5	3349	Fairchild
				2 M	-12,5	2518	Signetics
					-12,5	TMS3112	TI
					-12,5	TMS3122	TI
					-12,5	TMS3123	TI
40	6	SS	PMOS	2 M	-12,5	2519	Signetics
50	2	SS	PMOS	1 M	-12,5	SL5-2050	GI
					-12,5	SL6-2050	† GI
				1.5 M	-14,12	EA1013	EA
					-12,±5	2509	Signetics
				3 M	-14,12	EA1012	EA
64	1	SS	CMOS	1 M	3-15	CD4031BE	RCA
				2 M	3-15	CD4031B	† RCA
				2.7 M	3-16 (Cont'd)	MC14557BA	† Motorola

Bits Per Register	No of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
Static (Cont'd)							
64	1	SS	CMOS	2.7 M		(Cont'd)	
						F4557BM	† Fairchild
				5 M	3-18	MC14557B	Motorola
						F4557BC	Fairchild
				10 M	5-16	MS612	† Ragen
	2	SS	CMOS	4 M	3-15	MC14517BC	Motorola
					3-15	MC14517BA	† Motorola
			PMOS	1 M	-12,5	SL5-2064	GI
					-12,5	SL6-2064	† GI
				2 M	-12,5	MTS2105	† MOS
	4	SS	CMOS	4 M	3-15	F4731BC	Fairchild
					3-15	F4731BM	† Fairchild
			PMOS	1.5 M	-12,5	3342	Fairchild
				2 M	-12,5	ITT3342	ITT
				2.5 M	-12,5	TMS3121	TI
80	2	SS	PMOS	1.5 M	-14,12	EA1009	EA
					-12,5	3341	Fairchild
				2.2 M	-12,5	MM4052	National
					-12,5	MM5052	National
				2.5 M	-12,5	AM2847M	† AMD
				3 M	-12,5	AM2847C	AMD
					-14,12	EA1008	EA
	4	SS	NMOS	3 M	5	M142	SGS
		SS	PMOS	1.5 M	-12,5	3343	Fairchild
					-12,5	2532	Signetics
				2 M	-12,5	3357-2	Fairchild
						ITT3347	ITT
				2.5 M	-12,5	AM2847M	† AMD
					-12,5	2532-1	Signetics
					-12,5	TMS3120	TI
				3.0 M	-12,5	AM2847C	AMD
					-12,5	ITT3357	ITT
				4.0 M	-12,5	3357-1	Fairchild
	9	SS	PMOS	1.5 M	-12,5	TMS3135	TI
64,72,80		SS	PMOS	1.5 M	-12,5	MM5054	National
96	2	SS	PMOS	2.5 M	-12,5	TMS3126	TI
	4	SS	PMOS	2.5 M	-12,5	AM2896M	† AMD
				3.0 M	-12,5	AM2896C	AMD
100	1	SS	PMOS	1.5 M	-14,12	EA1005	EA
				2.5 M	-12,5	TMS3101	TI
					-12,5	TMS3127	TI
				3 M	-14,12	EA1004	EA
	2	SS	PMOS	1 M	-28,-14	MTS1102	MOS
				1.5 M	-27,-13	M127	SGS
					-12,±5	2510	Signetics
				1.6 M	-12,5	MM4053	National
					-12,5	MM5053	National
				2 M	-12,5	MCS2102	† MOS
					-12,5	SL5-C2100	GI
	4	SS	PMOS	2.2 M	-12,5	MM5061	National
	9	SS	PMOS	1.5 M	-12,5 (Cont'd)	TMS3137	TI

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Bold face indicates additional data is provided on the page noted.

MEMORY—Shift Registers (Cont'd)

Bits Per Register	No of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
Static (Cont'd)							
100						(Cont'd)	
20-100	2	SS	PMOS	2.5 M	-12,5	MM4007	National
125	1	SS	PMOS	1 M	-12,5	ITT1144	ITT
128	1	SS	Bipolar	60 M	5/-5.2	SR128	TRW
			CMOS	5 M	12	MS625	† Ragen
	2	SS	PMOS	1 M	-12,5	MK1002	AMD
					-12,5	MK1002	Mostek
					-12,5	SL5-2128	GI
				1.5 M	-12,5	2521	Signetics
					-12,5	MTS2107	† MOS
					-12,5	MM5060AA	National
				2 M	-12,5	AM2809M	† AMD
					-12,5	AM2810	AMD
					-12,5	TMS3114	AMD
					-12,5	3343	Fairchild
					-12,5	SL5-C2128	GI
					-12,5	MTS2108	† MOS
					-12,5	TMS3114	TI
				2.5 M	-12,5	AM2809C	AMD
					-12,5	AM2814M	† AMD
					-12,5	TMS3128	TI
	4	SS	PMOS	1.0 M	-12,5	MM4055	† National
				1.5 M	-12,5	MM5055	National
				2.5 M	-12,5	AM2855	AMD
					-12,5	AM4055	† AMD
					-12,5	AM5055	AMD
	9	SS	PMOS	1.5 M	-12,5	TMS3138	TI
16-128	1	SS	CMOS	5.6 M	3-15	MC14562B	Motorola
132	2	SS	PMOS	1.5 M	-12,5	MM5060AB	National
					-12,5	2522	Signetics
				2.5 M	-12,5	TMS3129	TI
	9	SS	PMOS	1.5 M	-12,5	TMS3139	TI
133	2	SS	PMOS	1.5 M	-12,5	MM5060AC	National
				2M	-12,5	TMS3113	TI
				2.5 M	-12,5	TMS3130	TI
	9	SS	PMOS	1.5 M	-12,5	TMS3140	TI
136	2	SS	PMOS	2.5 M	-12,5	TMS3131	TI
	9	SS	PMOS	1.5 M	-12,5	TMS3141	TI
125-144	2	SS	PMOS	1.5 M	-12,5	MM5060	National
144	1	SS	PMOS	1 M	-12,5	ITT1144	ITT
	2	SS	PMOS	1.5 M	-12,5	MM5060AD	National
				2 M	-12,5	3346	Fairchild
				2.5 M	-12,5	TMS3132	TI
	9	SS	PMOS	1.5 M	-12,5	TMS3142	TI
200	2	SS	PMOS	1.5 M	-12,±5	2511	Signetics
240	2	SS	PMOS	1.5 M	-12,5	2529	Signetics
250	2	SS	PMOS	1.5 M	-12,5	2528	Signetics
256	2	SS	PMOS	1.0 M	-12,5	MM4056	† National
				1.5 M	-12,5	MM5056	National
					-12,5	2527	Signetics
				2.5 M	-12,5 (Cont'd)	AM2856C	AMD

Bits Per Register	No of Reg.	Operation	Process	Frequency (Hz - Spec)	Supply Voltage	Device	Source
Static (Cont'd)							
256	2	SS	PMOS	2.5 M		(Cont'd)	
					-12,5	AM4056	† AMD
					-12,5	AM5056	AMD
480	2		NMOS	1.5 M	5	SY2535	Synertek
				3.0 M	5	SY2535A	Synertek
512	1	SS	PMOS	1.0 M	-12,5	MM4057	† National
				1.5 M	-12,5	MM5057	National
				2.5 M	-12,5	AM2857C	AMD
					-12,5	AM4057	† AMD
					-12,5	AM5057	AMD
	2		NMOS	1.5 M	5	SY2534	Synertek
				3.0 M	5	SY2534A	Synertek
1024	1	SS	NMOS	1.5 M	5	SY2533	Synertek
				2 M	5	IM7733C	Intersil
					5	IM7733M	† Intersil
					5	SY2833	Synertek
				3.0 M	5	SY2833A	Synertek
				4.0 M	5	SY2833B	Synertek
				5.0 M	5	SY2833C	Synertek
			PMOS	1.5 M	-12,5	AM2533C	AMD
					-12,5	2533	Fairchild
					-12,5	MM5058	National
					-12,5	2533	Signetics
				2 M	-12,5	AM2833C	AMD
					-12,5	AM2833M	† AMD
					-12,5	TMS3133	TI
				4 M	-12,5	3355C	Fairchild

† Military Temperature Range (−55°C to 125°C)

SS = Serial In, Serial Out

PP = Parrallel In, Parallel Out

RAMs

Part No.	Organization	Process	T_{Acc} (ns)	R/W T_{Cycle} (ns)	Operating Power (mW)	Standby Power (mW)	Supplies (V)	I/O	Clocks	Packages
Random Access Memories										
S2222	512 x 1 Static	CMOS	200	470	7.5	0.002	+10	MOS	0	2H,1U
S2222A	512 x 1 Static	SiGate	400	940	7.5	0.01	+10	MOS	0	2H,1U
S1103	1024 x 1 Dynamic	P-SiGate	310	580	450	–	+16, +19	MOS/Sense A.	3	2P,1P
S146	1024 x 1 Dynamic	P-SiGate	210	390	550	–	+19, +22	MOS/Sense A.	3	2P,1P
S1103-1	1024 x 1 Dynamic	P-SiGate	180	360	550	–	+19, +22	MOS/Sense A.	3	2P,1P
S1103X	1024 x 1 Dynamic	P-SiGate	120	270	550	–	+19, +22	MOS/Sense A.	3	2P,1P
S1103A	1024 x 1 Dynamic	P-SiGate	205	580	425	2.0	+16, +19	MOS/Sense A.	2	2P,1P
S1103A-1	1024 x 1 Dynamic	P-SiGate	145	340	660	0.2	+19, +22	MOS/Sense A.	2	2P,1P
S1103A-X	1024 x 1 Dynamic	P-SiGate	125	285	660	0.2	+19, +22	MOS/Sense A.	2	2P,1P
S4006	1024 x 1 QuasiStat	P-I^2	400	650	450	50	-12, +5	TTL	0	2H,4H
S4008	1024 x 1 QuasiStat	P-I^2	500	900	450	50	-12, +5	TTL	0	2H,4H
S4008-9	1024 x 1 QuasiStat	P-I^2	800	1000	450	50	-12, +5	TTL	0	2H,4H
S4015	1024 x 1 Static	N-SiGate	95	120	500	–	+5	TTL/Open C.	2	2H
S4015-2	1024 x 1 Static	N-SiGate	70	90	625	–	+5	TTL/Open C.	2	2H
S4025	1024 x 1 Static	N-SiGate	95	120	500	–	+5	TTL/3-State	2	2H
S4025-2	1024 x 1 Static	N-SiGate	70	90	625	–	+5	TTL/3-State	2	2H
S5101	256 x 4 Static	CMOS SiGate	650	650	110	0.05	+5	TTL/3-State	4	1C,2C
S5101-1	256 x 4 Static		450	450	110	0.05	+5	TTL/3-State	4	1C,2C
S5101-2	256 x 4 Static		450	450	110	0.7	+5	TTL/3-State	4	1C,2C
S5101-3	256 x 4 Static		650	650	110	0.7	+5	TTL/3-State	4	1C,2C
S5101-8	256 x 4 Static		800	800	110	2.5	+5	TTL/3-State	4	1C,2C
S5101L	256 x 4 Static		650	650	110	0.05	+5	TTL/3-State	4	1C,2C
S5101L-1	256 x 4 Static		450	450	110	0.05	+5	TTL/3-State	4	1C,2C
S5101L-2	256 x 4 Static		450	450	110	0.7	+5	TTL/3-State	4	1C,2C
S5101L-3	256 x 4 Static		650	650	110	0.7	+5	TTL/3-State	4	1C,2C
S6508	1024 x 1 Static	CMOS	460	730	50	0.5	+5	TTL	2	2H,4H
S6508A	1024 x 1 Static	CMOS	300	465	50	0.5	+5	TTL	2	2H,4H
S6810	128 x 8 Static	N-SiGate	1000	1000	650	N/A	+5	TTL	0	2L,1W
S6810-1	128 x 8 Static	N-SiGate	575	575	650	N/A	+5	TTL	0	2L,1W
S6810A	128 x 8 Static	N-SiGate	450	450	350	N/A	+5	TTL	0	2L,1W
S6810A-1	128 x 8 Static	N-SiGate	350	350	400	N/A	+5	TTL	0	2L,1W

ROMs/PROMs

Part No.	Description	Organization	Max. Power Dissip. (mW)	Supplies (V)	Max. Access Time	Process	Package
Read Only Memories							
S3514	4096 Bit Static ROM	512 x 8	500	+5, -12	1 μs	P-I^2	2L,1W
S5204A	4096 Bit Static EPROM	512 x 8	750	+5,-12	750 ns	P-SiGate	3L
S5232	4096 Bit Static ROM	512 x 8 or 1024 x 4	500	+5,-12	1 μs	P-I^2	2L,1W
S8564	9 x 7 Charac. Gen./ROM	64 Word	1100	+5,-12	450 ns	P-I^2	2I,1Z
S8771	5120 Bit ROM	512 x 10	1000	+5,-12	450 ns	P-I^2	2I,1Z
S8865	8192 Bit ROM	2048 x 4	635	+5,-12	1.3 μs	P-I^2	2L,1W(24);2I,1Z(28)
S8996	16,384 Bit ROM	4096 x 4	368	+5,-12	1.8 μs	P-I^2	2L,1W(24);2I,1Z(28)
S9996	16,384 Bit ROM	2048 x 8	368	+5,-12	1.8 μs	P-I^2	2L,1W(24);2I,1Z(28)
S6830	8192 Bit Static ROM	1024 x 8	650	+5	575 ns	N-SiGate	2L,1W
S6831	16,384 Bit Static ROM	2048 x 8	150	+5	450 ns	N-SiGate	3L
S6834	4096 Bit Static EPROM	512 x 8	750	+5,-12	575 ns	P-SiGate	3L
S6834-1	4096 Bit Static EPROM	512 x 8	750	+5,-12	750 ns	P-SiGate	3L

Notes: All ROMs are mask-programmable for custom patterns to meet your requirements.

Complete Data Sheets on all Standard Products Available from Your Local AMI Sales Office Listed Inside the Front Cover

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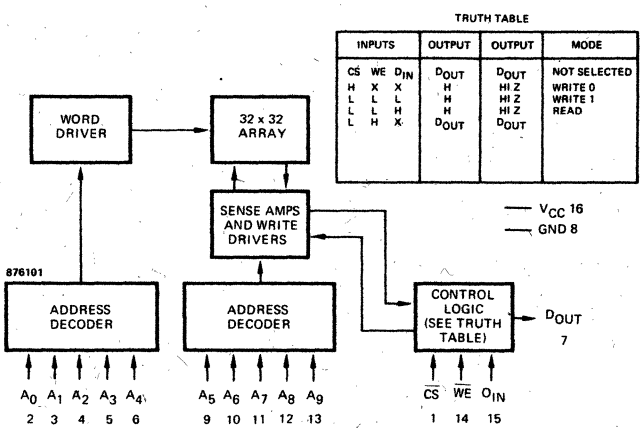
AMERICAN MICROSYSTEMS, INC.

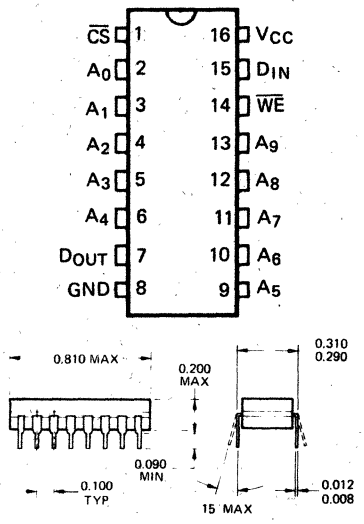
S4015/S4025

1024 x 1 HIGH SPEED STATIC RAM

ADVANCED PRODUCT DESCRIPTION



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION
16 LEAD CERDIP

FEATURES

- Fast Read Access Time
  S4015-2/S4025-2 – 70 nsec (Max.)
  S4015 /S4025 – 95 nsec (Max.)
- Fully Pin and Function Compatible to 93415/93425 1K Bipolar and 2115/2125 Intel NMOS
- Low Operating Power Dissipation: Typical 0.30 MW/Bit
- TTL Compatible Inputs and Output
- Single +5V Supply
- Non-Inverting Data Output
- Open Collector (S4015) and Three-State (S4025) Output
- N-Channel Silicon Gate Technology
- Low Cost Standard 16 Pin CerDip Dual In-Line Package.

FUNCTIONAL DESCRIPTION

The AMI S4015 and S4025 are a family of 1024 words by 1 bit fully decoded static Random Access Memories. These RAMs are designed for buffer and control storage and high performance, main memory applications. They are fully compatible with TTL logic families in all respects: inputs, outputs, and single +5V supply. Both open collector (S4015) and three-state output (S4025) are available.

TYPICAL APPLICATIONS

Buffer, Cache, Mainframe Memory, Control Storage, Add-On Memory, Etc.

The S4015 and S4025 family is fabricated with N-Channel MOS silicon gate process. The design takes advantage of depletion load transistors to achieve higher speed. The simple design and process allows the production of high speed MOS RAMs which are compatible to the performance of Bipolar RAMs, but offering the advantages of lower power dissipation and cost.

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Absolute Maximum Ratings*

Temperature Under Bias	-10°C to +85°C
Storage Temperature	-65°C to +150°C
All Output or Supply Voltages	-0.5 to +7 Volts
All Input Voltages	-0.5 to +5.5 Volts
D.C. Output Current	20mA

Comment:

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or at any other condition above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

D.C. Characteristics [1] V_{CC} = 5V ±5%, T_A = 0°C to 75°C

Symbol	Test	Min.	Typ.	Max.	Unit	Conditions
V_{OL1}	S4015-2 Output Low Voltage			0.45	V	I_{OL} = 16mA
V_{OL2}	S4015 Output Low Voltage			0.45	V	I_{OL} = 12mA
V_{OL3}	S4025 Family Output Low Voltage			0.45	V	I_{OL} = 7mA
V_{IH}	Input High Voltage	2.1			V	
V_{IL}	Input Low Voltage			0.8	V	
I_{IL}	Input Low Current		-1	-40	μA	V_{CC} = Max., V_{IN} = 0.4V
I_{IH}	Input High Current		1	40	μA	V_{CC} = Max., V_{IN} = 4.5V
I_{CEX}	S4015 Family Output Leakage Current		10	100	μA	V_{CC} = Max., V_{OUT} = 4.5V
$\|I_{OFF}\|$	S4025 Family Output Current (High Z)		10	50	μA	V_{CC} = Max., V_{OUT} = 0.5V/2.4V
I_{OS} [2]	S4025 Family Current Short Circuit to Ground			-100	mA	V_{CC} = 4.5V
V_{OH}	S4025 Family Output High Voltage	2.4			V	I_{OH} = -3.2mA
I_{CC1}	S4015, S4025, Power Supply Current		60	100	mA	All Inputs Grounded, Output Open
I_{CC2}	S4015-2, S4025-2, Power Supply Current		100	125	mA	All Inputs Grounded, Output Open

NOTES: 1. The operating ambient temperature ranges are guaranteed with transverse air flow exceeding 400 linear feet per minute and a two minute warm-up. Typical thermal resistance values of the package at maximum temperature are:

θ_{JA} (@ 400 f_{PM} air flow) = 45°C/W
θ_{JA} (still air) = 60°C/W
θ_{JC} = 25°C/W

2. Duration of short circuit current should not exceed 1 second.

TRUTH TABLE

Inputs			Output S4015 Family	Output S4025 Family	Mode
CS	WE	D_{IN}	D_{OUT}	D_{OUT}	
H	X	X	H	High Z	Not Selected
L	L	L	H	High	Write "0"
L	L	H	H	High	Write "1"
L	H	X	D_{OUT}	D_{OUT}	Read

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S4015 Family A.C. Characteristics [1] V_{CC} = 5V ±5%, T_A = 0°C to 75°C

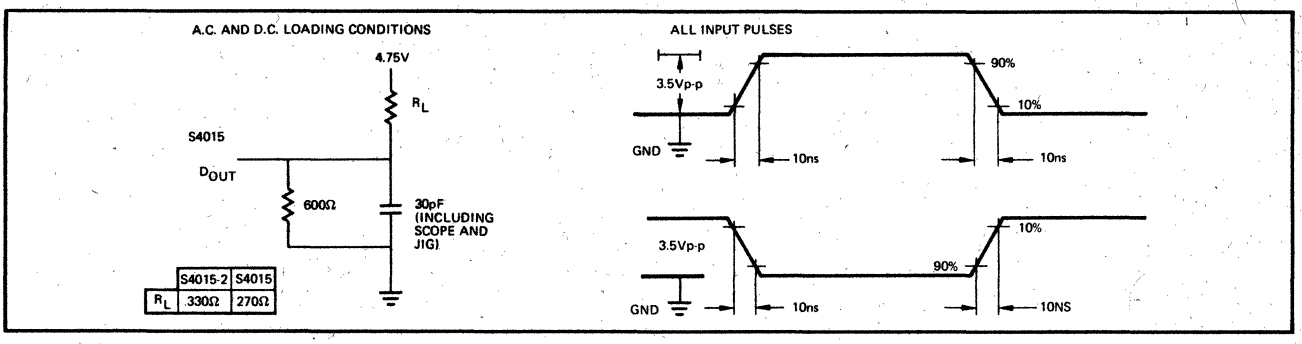
READ CYCLE

Symbol	Test	S4015-2 Limits Min.	Typ.	Max.	S4015 Limits Min.	Typ.	Max.	Units
t_{ACS}	Chip Select Time	5		40	5		45	ns
t_{RCS}	Chip Select Recovery Time			40			40	ns
t_{AA}	Address Access Time		60	70		75	95	ns
t_{OH}	Previous Read Data Valid After Change of Address	10			10			ns

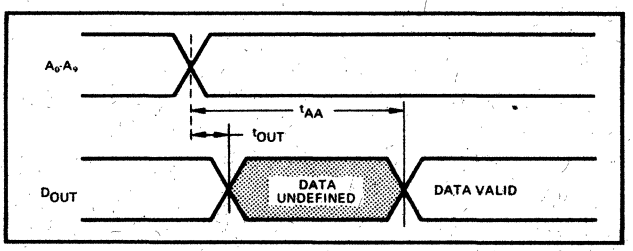
WRITE CYCLE

Symbol	Test	Min.	Typ.	Max.	Min.	Typ.	Max	Units
t_{WS}	Write Enable Time			40			40	ns
t_{WR}	Write Recovery Time	5		45	5		45	ns
t_W	Write Pulse Width	50			50			ns
t_{WSD}	Data Set-Up Time Prior to Write	5			5			ns
t_{WHD}	Data Hold Time after Write	5			5			ns
t_{WSA}	Address Set-Up Time	15			30			ns
t_{WHA}	Address Hold Time	5			5			ns
t_{WSCS}	Chip Select Set-Up Time	5			5			ns
t_{WHCS}	Chip Select Hold Time	5			5			ns

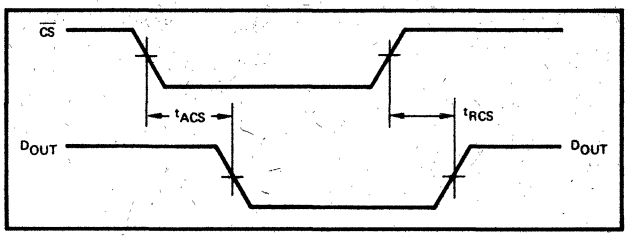
TEST CONDITIONS



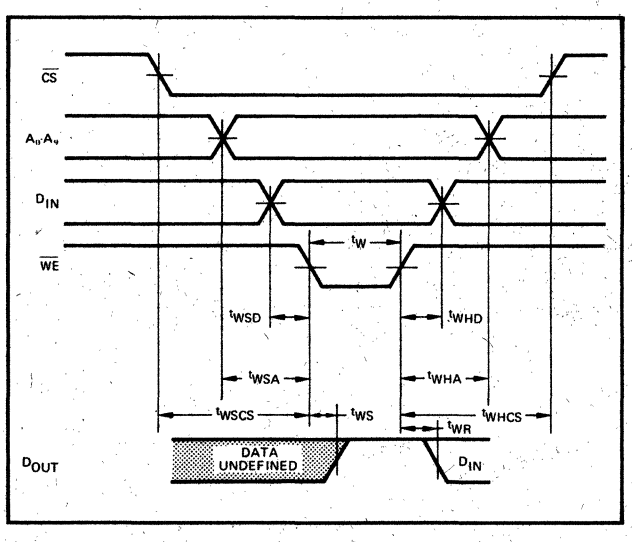
READ CYCLE



PROPAGATION DELAY FROM CHIP SELECT



WRITE CYCLE



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S4025 Family A.C. Characteristics [1] V_{CC} = 5V ±5%, T_A = 0°C to 75°C

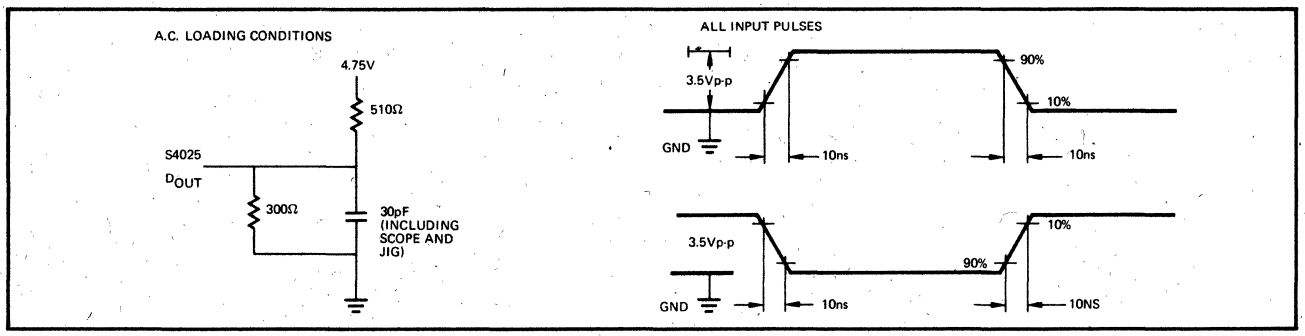
READ CYCLE

Symbol	Test	S4025-2 Limits Min.	Typ.	Max	S4025 Limits Min.	Typ.	Max.	Units
t_{ACS}	Chip Select Time	5		40	5		45	ns
t_{ZRCS}	Chip Select to HIGH Z			40			40	ns
t_{AA}	Address Access Time		60	70		75	95	ns
t_{OH}	Previous Read Data Valid after Change of Address	10			10			ns

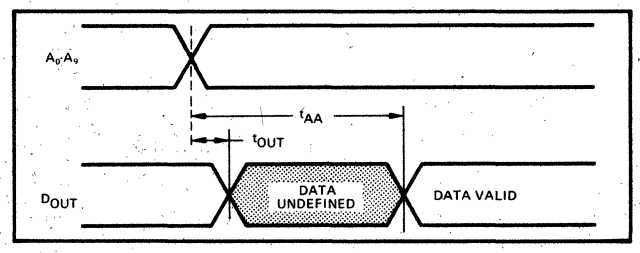
WRITE CYCLE

Symbol	Test	Min.	Typ.	Max.	Min.	Typ.	Max.	Units
t_{ZWS}	Write Enable to HIGH Z			40			40	ns
t_{WR}	Write Recovery Time	5		45	5		45	ns
t_W	Write Pulse Width	50			50			ns
t_{WSD}	Data Set-Up Time Prior to Write	5			5			ns
t_{WHD}	Data Hold Time After Write	5			5			ns
t_{WSA}	Address Set Up Time	15			30			ns
t_{WHA}	Address Hold Time	5			5			ns
t_{WSCS}	Chip Select Set-Up Time	5			5			ns
t_{WHCS}	Chip Select Hold Time	5			5			ns

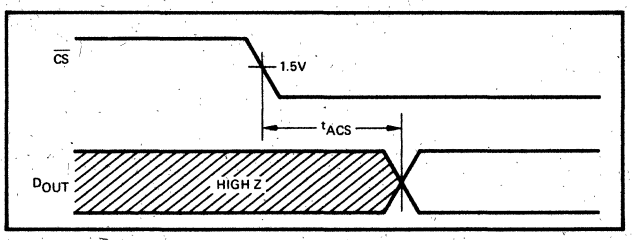
TEST CONDITIONS



READ CYCLE

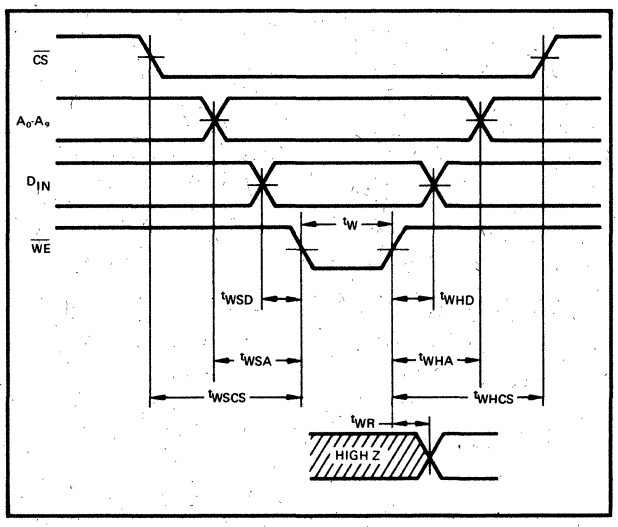


PROPAGATION DELAY FROM CHIP SELECT



(ALL ABOVE MEASUREMENTS REFERENCED TO 1.5V)

WRITE CYCLE



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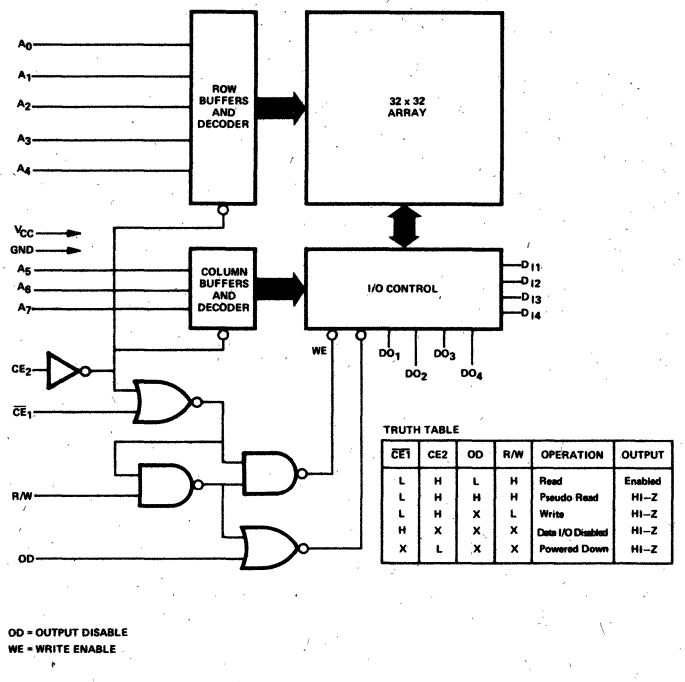
AMERICAN MICROSYSTEMS, INC.

S5101

1024 BIT (256 x 4)
STATIC CMOS RAM

ADVANCED PRODUCT DESCRIPTION



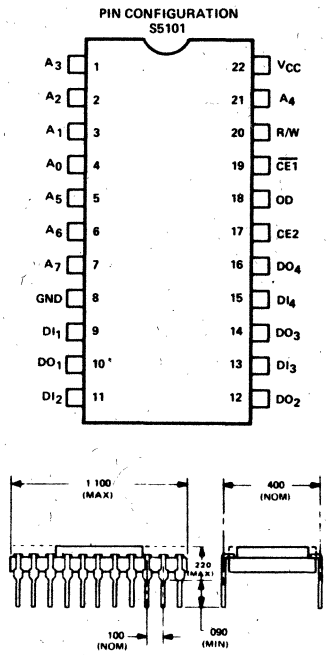
TRUTH TABLE

$\overline{CE1}$	CE2	OD	R/W	OPERATION	OUTPUT
L	H	L	H	Read	Enabled
L	H	H	H	Pseudo Read	HI-Z
L	H	X	L	Write	HI-Z
H	X	X	X	Data I/O Disabled	HI-Z
X	L	X	X	Powered Down	HI-Z

OD = OUTPUT DISABLE
WE = WRITE ENABLE

1076144

BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- Ultra Low Standby Power – 50 Nanowatt/Bit Maximum
- Fast Access Time: 450 nsec Maximum
- Static – No Refresh
- Single +5 Volt Power Supply
- Completely TTL Compatible – All Inputs and Outputs
- Data Retention at 2.0V
- Pin Compatible, Industry Standard
- Low Power Replacement for N-Channel Static 2101
- Three State Output
- Common or Separate I/O
- 22 Pin Dual In-Line Package

FUNCTIONAL DESCRIPTION

The AMI S5101 family of 256 x 4 bit high speed CMOS RAMs offers ultra low power and fully static operation with a single 5 volt power supply. With data inputs and outputs on adjacent pins, either separate or common data I/O applications can be easily selected for maximum design flexibility. The very low power of these RAMs makes them an ideal choice where battery augmented non-volatile RAM storage is mandatory.

The S5101 family is totally static, making clocking unnecessary for a new address to be accepted. The stored data is read out nondestructively and in the same polarity as the original input data. The outputs are disabled with output disable (O.D.), either ($\overline{CE_1}$) or (CE_2), or during a write cycle (R/W = LOW). The read/write input or output disable input allows these RAMs to be used in common data I/O systems by forcing the output into a high impedance state during a write operation.

When deselected, the S5101 and S5101-3 draw only 10 microamps and 140 microamps, respectively, from the 5 volt supply. The S5101L and S5101L-3 are identical to the S5101 and S5101-3, respectively, with the additional feature of guaranteed data retention at a power supply voltage as low as 2.0 volts.

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ABSOLUTE MAXIMUM RATINGS*

Ambient Temperature Under Bias	0°C to 70°C	Maximum Power Supply Voltage	+11V
Storage Temperature	- 65°C to + 150°C	Power Dissipation	1 Watt
Voltage on Any Pin with Respect to Ground	- 0.3V to V_{CC} + 1.0V		

**COMMENT:* *Stresses above those listed under "Absolute Maximum Rating" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or at any other condition above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

D.C. CHARACTERISTICS T_A = 0°C to 70°C, V_{CC} = 5V ± 5% (Unless otherwise specified)

SYMBOL	PARAMETER	LIMIT MIN.	LIMIT MAX.	UNITS	TEST CONDITIONS
I_{LI}	Input Leakage Current		1	μA	V_{IN} = 0V to V_{CC}
I_{LO}	Output Leakage Current		1	μA	$\overline{CE}_1 = V_{IH}$ $CE_2 = V_{IN}$ V_{OUT} = 0V or V_{CC}
I_{CC}	Operating Supply Current		22	mA	Outputs = Open, $V_{IN} = V_{IL}$ to V_{CC}
I_{CCL}	Standby Supply Current S5101 S5101-3		 10 140	 μA μA	 V_{IN} = 0V to V_{CC} except $CE_2 \leqslant 0.2V$
V_{IL}	Input Low Voltage	- 0.3	0.65	V	
V_{IH}	Input High Voltage	2.2	V_{CC}	V	
V_{OL}	Output Low Voltage		0.4	V	I_{OL} = 2 mA
V_{OH}	Output High Voltage	2.4		V	I_{OH} = - 1 mA

LOW V_{CC} [1] DATA RETENTION CHARACTERISTICS FOR S5101L, S5101L-3 T_A = 0°C to 70°C

SYMBOL	PARAMETER	LIMIT MIN.	LIMIT MAX.	UNITS	TEST CONDITIONS
V_{DR}	V_{CC} for Data Retention	2.0		V	$CE_2 \leqslant 0.2V$
I_{CCDR}	Data Retention Supply Current S5101L S5101L-3		 2 30	 μA μA	$V_{CC} = V_{DR}$ $t_R = t_F$ = 20 ns
t_{CDR}	Chip Deselect to Data Retention Time	0		ns	
t_R	Operation Recovery Time	t_{RC} [2]		ns	

NOTES:
[1] For guaranteed low V_{CC} Data Retention @ 2.0V, order should include S5101L or S5101L-3 Numbers.
[2] t_{RC} = Read Cycle Time.

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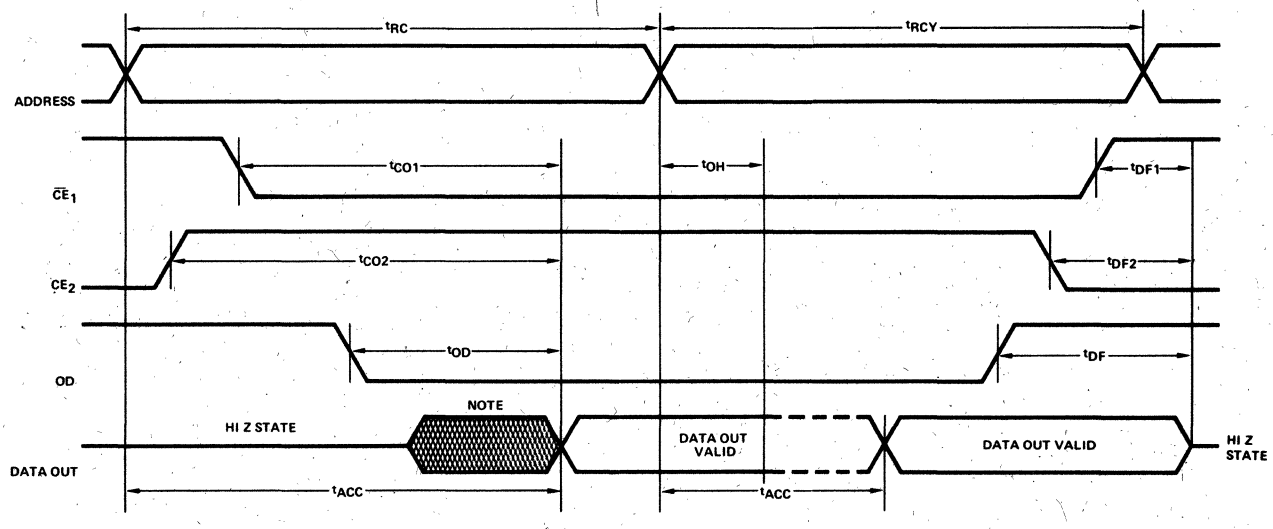
A.C. CHARACTERISTICS

T_A = 0°C to 70°C, V_{CC} = 5V ± 5% (Unless otherwise specified)

READ CYCLE

SYMBOL	PARAMETER	S5101-1 & S5101L-1 LIMITS		S5101, S5101L S5101-3, S5101L-3 LIMITS		S5101-8 LIMITS		UNITS	COMMENTS
		MIN	MAX	MIN	MAX	MIN	MAX		
T_{RC}	Read Cycle Time	450		650		800		ns	SEE A.C. CONDITIONS OF TEST AND A.C. TEST LOAD
T_{ACC}	Access Time		450		650		800	ns	
T_{CO1}	CE1 to Output Delay		420		600		800	ns	
T_{CO2}	CE2 to Output Delay		500		700		900	ns	
T_{OD}	Output Disable to Enabled Output Delay		300		350		500	ns	
T_{DF}	Output Disable To Output HI-Z Stage Delay	30		50		50		ns	
T_{DF1}	CE1 To Output H-Z Delay	30		50		50		ns	
T_{DF2}	CE2 To Output HI-Z Delay	30		50		50		ns	
T_{OH}	Output Data Valid Into Next Cycle	30		50		50		ns	

READ CYCLE



NOTE: THE INDETERMINATE STATE OF THE OUTPUT WILL OCCUR FOR SOME TIME PERIOD BETWEEN 0ns AND THE FULL DURATION OF t_{CO1}, AFTER BOTH OD AND $\overline{CE}_1$ HAVE GONE LOW.

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A.C. CHARACTERISTICS FOR WRITE CYCLE – SEPARATE OR COMMON DATA I/O USING OUTPUT DISABLE

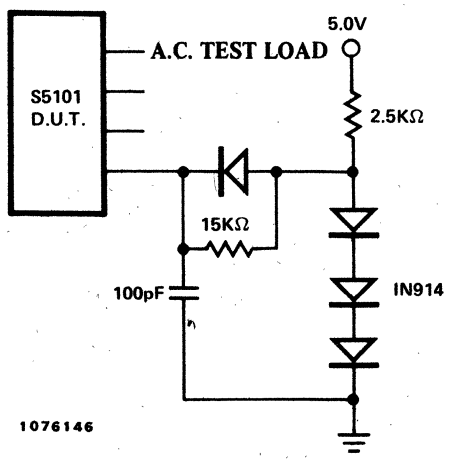
T_A = 0°C to 70°C, V_{CC} = 5V ± 5% (Unless otherwise specified)

WRITE CYCLE

SYMBOL	PARAMETER	S5101-1 & S5101L-1 LIMITS		S5101, S5101L S5101-3, S5101L-3 LIMITS		S5101-8 LIMITS		UNITS	COMMENTS
		MIN	MAX	MIN	MAX	MIN	MAX		
T_{WC}	Write Cycle Time	450		650		800		ns	SEE A.C. CONDITIONS OF TEST AND A.C. TEST LOAD
T_{AW}	Address To Write Delay	130		150		200		ns	
T_{CW1}	CE1 to Write Delay	400		550		800		ns	
T_{CW2}	CE2 to Write Delay	400		550		800		ns	
T_{DW}	Data Set-Up to End of Write Time	250		400		500		ns	
T_{DH}	Data Hold After End of Write Time	50		100		100		ns	
T_{WP}	Write Pulse Width (For Write Cycle 1)	250		400		500		ns	
T_{WR}	End of Write to New Address Recovery Time	70		100		100		ns	
T_{DS}	Output Disable to Data-In Set-Up Time	130		150		200		ns	

CAPACITANCE

SYMBOL	PARAMETERS	LIMIT MIN.	LIMIT MAX.	UNITS	TEST CONDITIONS
C_{IN}	Input Capacitance		8	pF	V_{IN} = 0V, on all Input Pin
C_O	Output Capacitance		12	pF	V_O = 0V



A.C. CONDITION OF TEST

Input Levels	0.65 Volt to 2.2 Volt
Input Rise and Fall	20 ns
Timing Measurement Reference Level	1.5 Volt

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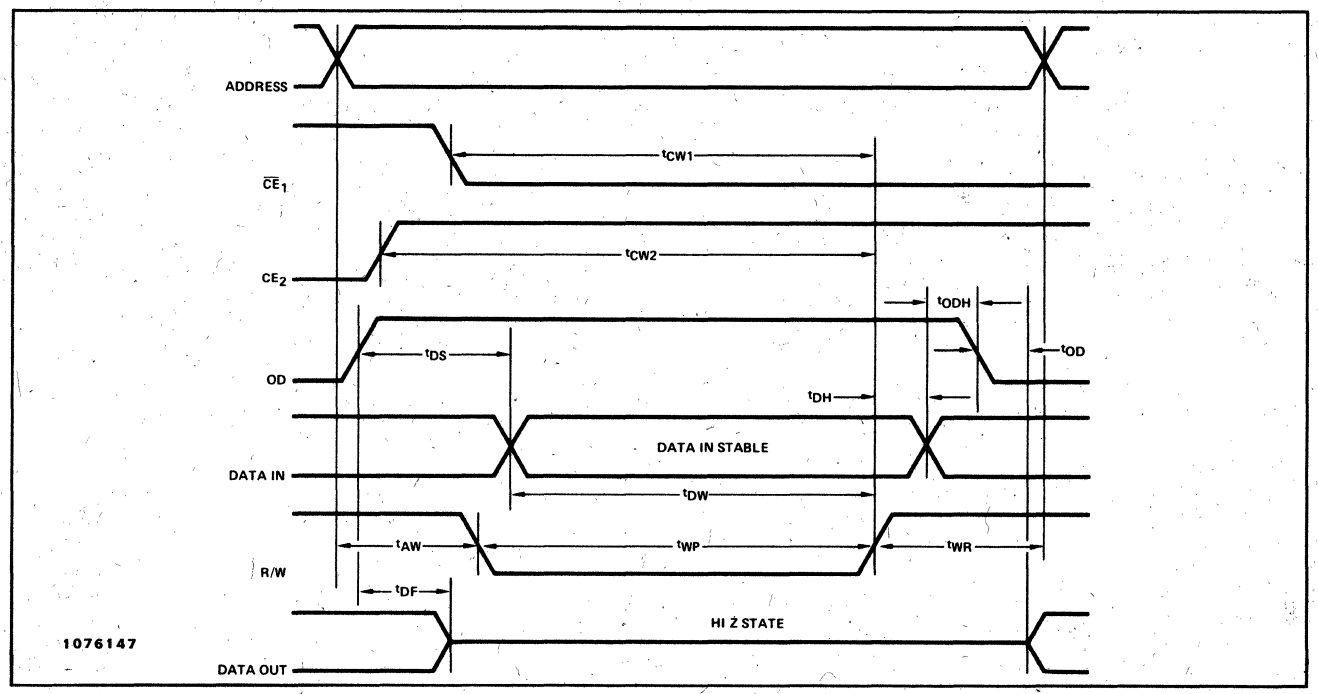
WRITE CYCLE 1 – FOR SEPARATE OR COMMON DATA I/O



PRODUCT SELECTION GUIDE

DEVICE NUMBER	ACCESS TIME (NS)	STANDBY CURRENT μA/DEVICE	POWER DOWN GUARANTEED AT 2.0V
S5101-3	650	140	NO
S5101L-3	650	140	YES
S5101	650	10	NO
S5101L	650	10	YES
S5101-2	450	140	NO
S5101L-2	450	140	YES
S5101-1	450	10	NO
S5101L-1	450	10	YES
S5101-8	800	500	NO

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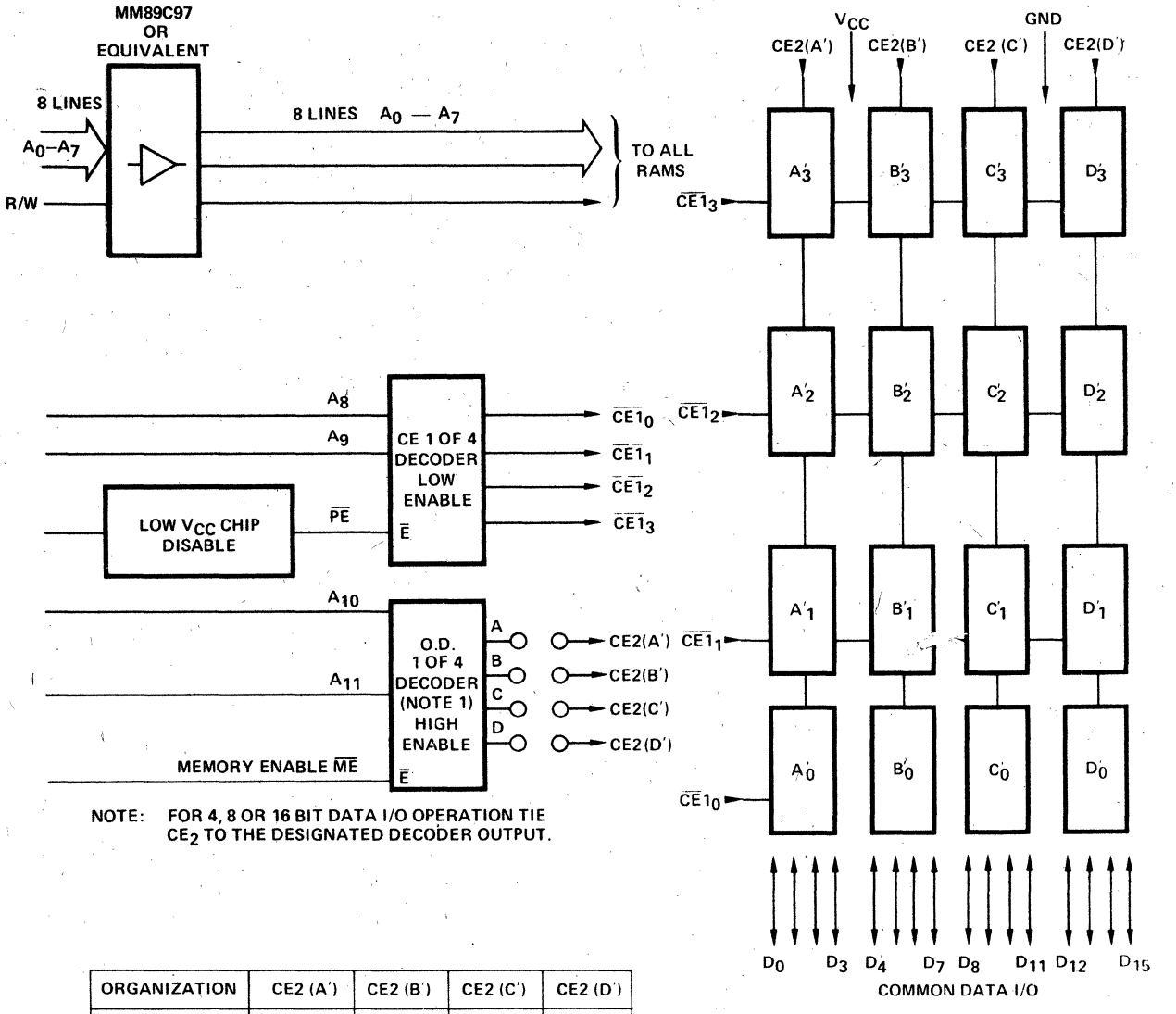
A 1024 x 16 BIT (or 2K x 8 or 4K x 4) CMOS READ/WRITE MEMORY



NOTE: FOR 4, 8 OR 16 BIT DATA I/O OPERATION TIE CE_2 TO THE DESIGNATED DECODER OUTPUT.

ORGANIZATION	CE2 (A')	CE2 (B')	CE2 (C')	CE2 (D')
1K x 16 BIT	A'	A'	A'	A'
2K x 8 BIT	A'	A'	B'	B'
4K x 4 BIT	A'	B'	C'	D'

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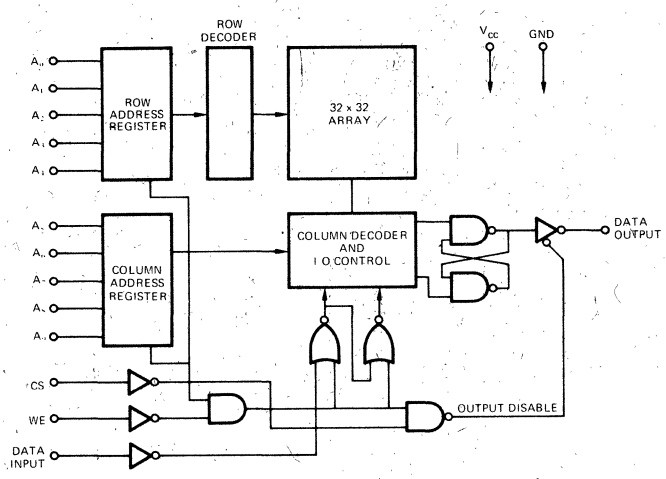
AMERICAN MICROSYSTEMS, INC.

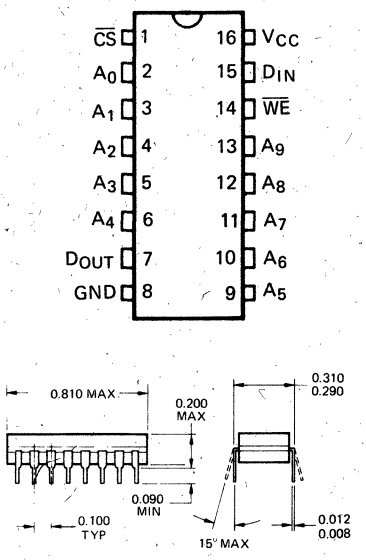
S6508/S6508A

1024 x 1 BIT
STATIC CMOS RAM

ADVANCED PRODUCTION DESCRIPTION



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- Data Retention Power: 1.0nW/Bit Max.
- Ultra Low Standby Power: 50μW Max.
- Fast Access Time: 200μs Max. @ 10V
- Low Operating Power: 9mW @ 1 MHz
- 4V to 11V Operation
- Completely TTL Compatible
- Common Separate Data I/O Capability
- Three State Output
- Replaces Intersil IM6508, Harris HM6508

FUNCTIONAL DESCRIPTION

The AMI S6508 family of 1024 x 1 bit RAMs offers ultra low power dissipation and static operation with a single 4V to 11V power supply. Either separate or common Data I/O can be easily selected to maximize design flexibility. In applications requiring both high speed yet very low power for battery augmented non-volatile RAM storage, the S6508 family would be an ideal selection.

Address registers included in the device can improve and simplify system performance while reducing memory system package count. These internal registers latched on the HIGH to LOW transition of the chip select ($\overline{CS}$). With $\overline{CS}$ in the LOW state, S6508 family can perform the Read ($\overline{WE}$ = HIGH) or Write ($\overline{WE}$ = LOW) operations. The address which is written into or read out of was stored in the input registers when $\overline{CS}$ went LOW.

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CMOS TO CMOS – S6508A/S6508A-1

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	+12.0V
Input or Output Voltage Applied	-0.5V to V_{CC} +1.0V
Storage Temperature Range	-65°C to +150°C
Operating Temperature Range	
Commercial	0°C to +70°C
Industrial	-40°C to +85°C

AC CHARACTERISTICS (V_{CC} = 5.0V, 10V C_L = 50pF, T_A = 25°C)

SYMBOL	PARAMETER	LIMIT S6508A-1 MIN	LIMIT S6508A-1 MAX	LIMIT S6508A MIN	LIMIT S6508A MAX	UNITS
T_{AC}	Access Time from CS_1					
	V_{CC} = 5V		200		350	ns
	V_{CC} = 10V		95		150	ns
T_{EN}	Output Enable Time					
	V_{CC} = 5V		120		210	ns
	V_{CC} = 10V		55		90	ns
T_{DIS}	Output Disable Time					
	V_{CC} = 5V		120		210	ns
	V_{CC} = 10V		55		90	ns
T_{CS1}	CS_1 Pulse Width (POS)					
	V_{CC} = 5V	135		235		ns
	V_{CC} = 10V	65		95		ns
$T_{\overline{CS1}}$	CS_1 Pulse Width (NEG)					
	V_{CC} = 5V	200		350		ns
	V_{CC} = 10V	95		150		ns
T_{WP}	Write Pulse Width (NEG)					
	V_{CC} = 5V	135		235		ns
	V_{CC} = 10V	65		95		ns
T_{ADD}	Address Setup Time					
	V_{CC} = 5V	5		10		ns
	V_{CC} = 10V	5		10		ns
T_{ADDH}	Address Hold Time					
	V_{CC} = 5V	60		105		ns
	V_{CC} = 10V	30		45		ns
T_{DS}	Data Setup Time					
	V_{CC} = 5V	135		235		ns
	V_{CC} = 10V	65		95		ns
T_{PH}	Data Hold Time					
	V_{CC} = 5V	0		0		ns
	V_{CC} = 10V	0		0		ns

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DC CHARACTERISTICS (V_{CC} = 4V to 11V, T_A = Industrial)

SYMBOL	PARAMETER	LIMIT MIN	LIMIT MAX	UNITS	TEST CONDITIONS
V_{IH}	Logical "1" Input Voltage	70% V_{CC}		V	
V_{IL}	Logical "0" Input Voltage		20% V_{CC}	V	
I_{IL}	Input Leakage	-1.0	1.0	μA	$0V \leq V_{IN} \leq V_{CC}$
V_{OH}	Logical "1" Output Voltage	V_{CC}-0.01		V	$I_{OUT} = 0$
V_{OL}	Logical "0" Output Voltage		GND+0.01	V	$I_{OUT} = 0$
I_O	Output Leakage	-1.0	1.0	μA	$0V \leq V_O \leq V_{CC}$
I_{CC}	Supply Current S6508A		500	μA	$V_{IN} = V_{CC}$[1]
I_{CC}	Supply Current S6508A-1		100	μA	$V_{IN} = V_{CC}$[1]
I_{CC}	Supply Current S6508A/S6508A-1		3.5	mA	fc = 1MHz
C_{IN}	Input Capacitance		7.0	pF	
C_O	Output Capacitance		10.0	pF	

[1] Devices with data retention guaranteed at V_{CC}=2.0 are available.

CMOS TO TTL – S6508/S6508-1

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	+8.0V
Input or Output Voltage Supplied	GND -0.5V to V_{CC} +0.5V
Storage Temperature Range	-65°C to +150°C
Operating Temperature Range	
Commercial	0°C to +70°C
Industrial	-40°C to +85°C

AC CHARACTERISTICS (V_{CC} = 5.0V ±10%, C_L = 50pF (One TTL Load), T_A = 0°C to +70°C)

SYMBOL	PARAMETER	LIMIT S6508-1 MIN	LIMIT S6508-1 MAX	LIMIT S6508 MIN	LIMIT S6508 MAX	UNITS
T_{AC}	Access Time from CS_1		300		460	ns
T_{EN}	Output Enable Time		180		285	ns
T_{DIS}	Output Disable Time		180		285	ns
T_{CS1}	CS_1 Pulse Width (POS)	165		270		ns
$T_{\overline{CS1}}$	CS_1 Pulse Width (NEG)	300		460		ns
T_{WP}	Write Pulse Width (NEG)	165		270		ns
T_{ADDS}	Address Setup Time	7		15		ns
T_{DS}	Data Setup Time	165		270		ns
T_{DH}	Data Hold Time	0		0		ns

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DC CHARACTERISTICS (V_{CC} = 5.0V ±10%, T_A = 0°C to +70°C

SYMBOL	PARAMETER	LIMIT		UNITS	TEST CONDITIONS
		MIN	MAX		
V_{IH}	Logical "1" Inputs Voltage	V_{CC}-2.0	0.8	V	
V_{IL}	Logical "0" Input Voltage		0.8	V	
I_{IL}	Input Leakage	-1.0	1.0	μA	$0V \leqslant V_{IN} \leqslant V_{CC}$
V_{OH2}	Logical "1" Output Voltage	V_{CC}-0.01		V	$I_{OUT} = 0$
V_{OH1}	Logical "1" Output Voltage	2.4		V	$I_{OH} = -0.2mA$
V_{OL2}	Logical "0" Output Voltage		GND+0.01	V	$I_{OUT} = 0$
V_{OL1}	Logical "0" Output Voltage		0.45	V	$I_{OL} = 2.0mA$
I_O	Output Leakage	-1.0	1.0	μA	$0V \leqslant V_O \leqslant V_{CC}$
I_{CC}	Supply Current S6508		100	μA	$V_{IN} = V_{CC}$[1]
I_{CC}	Supply Current S6508-1		10	μA	$V_{IN} = V_{CC}$[1]
I_{CC}	Supply Current S6508/S6508-1		1.7	mA	fc = 1MHz
C_{IN}	Input Capacitance		7.0	pF	
C_O	Output Capacitance		10.0	pF	

[1]Devices with data retention guaranteed at V_{CC} = 2.0V are available.

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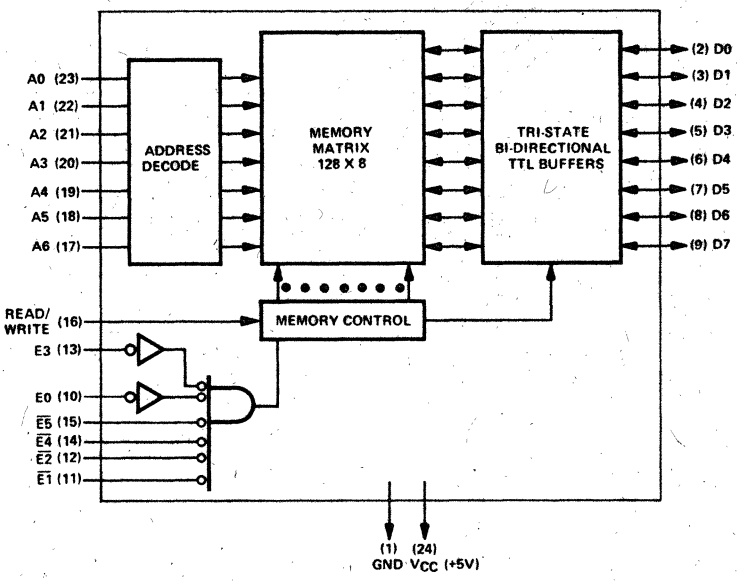
AMERICAN MICROSYSTEMS, INC.

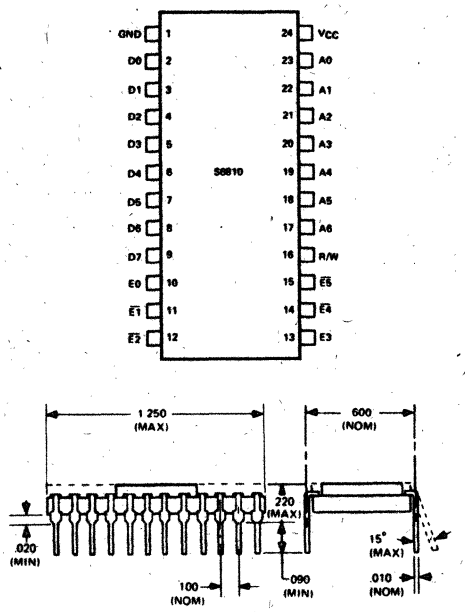
S6810

128 X 8 STATIC
READ/WRITE MEMORY

ADVANCED PRODUCT DESCRIPTION



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- Organized as 128 Bytes of 8 Bits
- Static Operation
- Bi-Directional Three-State Data Input/Output
- Six Chip Enable Inputs (Four Active Low, Two Active High)
- Single 5-Volt Power Supply
- TTL Compatible
- Maximum Access Time = 1.0μs for S6810
  575 ns for S6810-1

FUNCTIONAL DESCRIPTION

The S6810 is a static 128 x 8 Read/Write Memory designed and organized to be compatible with the S6800 Microprocessor. Interfacing to the S6810 consists of an 8 Bit Bi-directional Data Bus, Seven Address Lines, a single Read/Write Control line, and six Chip Enable lines, four negative and two positive.

For ease of use, the S6810 is a totally static memory requiring no clocks or cell refresh. The S6810 is fabricated with N channel silicon gate technology to be fully DTL/TTL compatible with only a single +5 volt power supply required.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC}	-0.3 to +7.0V
Input Voltage V_{in}	-0.3 to +7.0V
Operating Temperature Range T_A	0 to +70°C
Storage Temperature Range T_{stg}	-55 to +150°C

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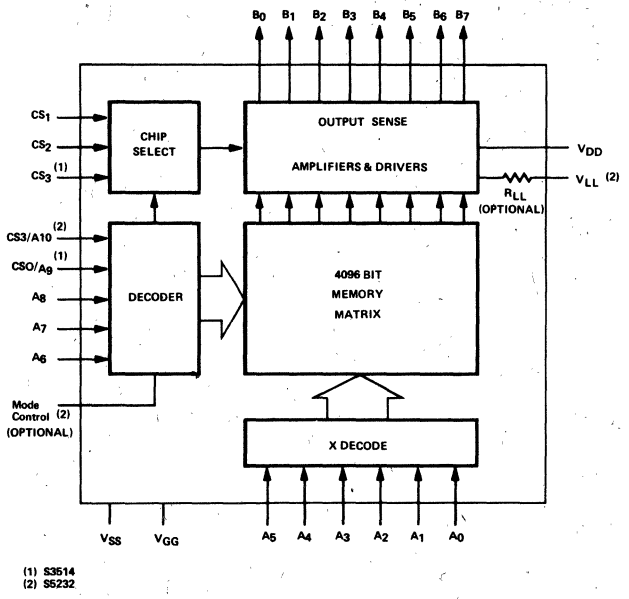
S3514
S5232

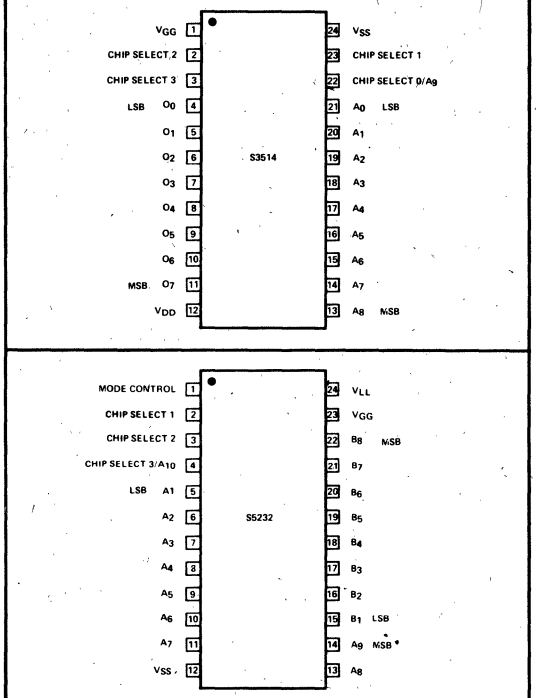
4096 BIT STATIC
MOS READ ONLY MEMORY

AMERICAN MICROSYSTEMS, INC.

ADVANCED PRODUCT DESCRIPTION

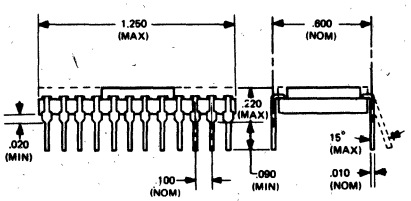


BLOCK DIAGRAM



FEATURES

- Static Operation – No Clocks Required
- High-speed –600 ns Typical Access Time
- Bus ORable Outputs – Three States
- Multiple ROM Control – 4 Chip Selects
- Standard Supplies – +5V, 0V, –12V
- S3514 Replaces FAIRCHILD 3514
- S5232 Replaces National MM 5232



PIN/PACKAGE CONFIGURATION
(Available in Pkgs. 2L, 1W - see Sec. 1)

FUNCTIONAL DESCRIPTION

The AMI S3514 and S5232 are TTL compatible MOS read-only memories (ROM) designed to store 4096 bits of information by programming one mask pattern. The word and bit organizations of these ROMs are either 512 x 8 or 1024 x 4. Both ROMs have push-pull outputs that can be in one of three states: HIGH, LOW or open (unselected state). This, plus the programmable Chip Selects, enables the use of several ROMs in parallel with no external components. Since the ROM is a static device, no clocks are required, making these ROMs both versatile and easy to use.

Low threshold-voltage processing, utilizing AMI's I^2TM is used with P-channel, depletion-mode MOS technology to provide direct output interfacing with TTL and DTL logic families. All inputs are protected to prevent damage from static charge accumulation.

TYPICAL APPLICATIONS

Code Conversion, Table Lookup, Microprogramming, Control Logic.

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ABSOLUTE MAXIMUM RATINGS

Voltage on Any Terminal Relative to V_{SS} (except V_{GG})	+ 0.3V to –10V
Voltage on V_{GG} Terminal Relative to V_{SS}	+ 0.3V to –20V
Operating Temperature Range (Ambient)	0°C to + 70°C
Storage Temperature Range (Ambient)	–55°C to + 150°C

RECOMMENDED OPERATING CONDITIONS

($0°C \leq T_A \leq 70°C$)

	Parameter	Min.	Max.	Units	Notes (Page 5-8)
V_{SS}	Supply Voltage	+4.75	+5.25	V	
V_{DD}	Supply Voltage	0	0	V	Note 1
V_{GG}	Supply Voltage	–11.4	–12.6	V	
V_{LL}	Output Load Voltage	0	–12.6	V	Note 2, 7
V_{IL}	Input Voltage, LOW Level	0	V_{SS}–4.0		
V_{IH}	Input Voltage, HIGH Level	V_{SS}–1.5	V_{SS}	V	Note 3
V_{IH}	Input Voltage, HIGH Level	V_{SS}–2.0	V_{SS}	V	Note 4

ELECTRICAL CHARACTERISTICS

(V_{SS} = +5.0V ± 5%; V_{DD} = 0V; V_{GG} = –12V ± 5%; V_{LL} = –12V ± 5%; $0°C \leq T_A \leq 70°C$ unless noted otherwise)

	Parameter	Min.	Max.	Units	Notes (Page 5-8)
I_{SS}	Supply Current, V_{SS}		28.0	mA	Note 5
I_{GG}	Supply Current, V_{GG}		28.0	mA	Note 5
R_{LL}	Output Load Resistor	500	2000	Ω	Note 7
$I_{I(L)}$	Input Leakage Current,		1.0	μA	$V_I = V_{SS}$ –6.0V. Note 3
I_{IL}	Input Current, LOW Level	0	–150	μA	$V_I = V_{SS}$ –4.0V. Note 4
I_{IH}	Input Current, HIGH Level	–200	–700	μA	$V_I = V_{SS}$ –2.0V. Note 4
V_{OL}	Output Voltage, LOW Level		0.4	V	I_{OL} = 1.6mA
V_{OH}	Output Voltage, HIGH Level	2.4		V	I_{OH} = –100μA
$I_{O(L)}$	Output Leakage Current		+10	μA	Outputs disabled ($V_O = V_{SS}$ –6V)
C_{IN}	Input Capacitance		10	pF	Note 6
C_O	Output Capacitance		10	pF	Note 6
t_{ACCESS}	Address to Output Access Time		1000	nsec	Note 8, See Timing
t_{CS}	Chip Select to Output Delay		800	nsec	
t_{CD}	Chip Deselect to Output Delay		800	nsec	

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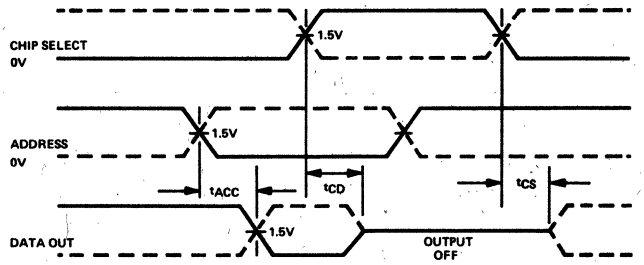
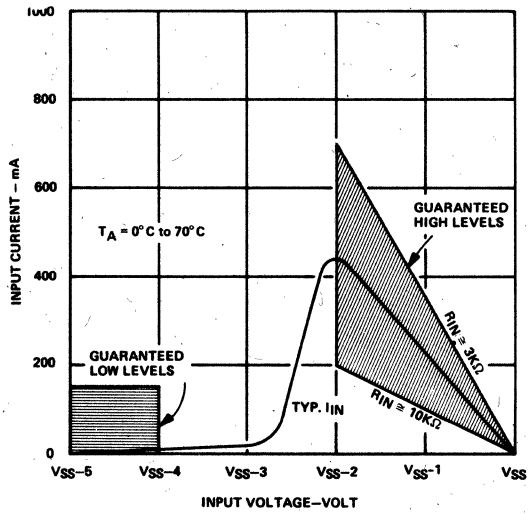
NOTES:
1. Not available on S5232
2. Not available on S3514
3. This parameter is for inputs without active pull-ups (programmable).
4. This parameter is for inputs with active pull-ups (programmable) for TTL interfaces. As the TTL driver goes to a HIGH level it must only provide $V_{SS}-2.0V$ (this voltage must not be clamped) and the input circuit pulls the output of the TTL device to V_{SS}. See Optional Input Pull-up Characteristics.
5. Inputs at V_{SS}, outputs unloaded. V_{DD} current comes only from the output loads.
6. $V_{Bias} - V_{SS} = 0V$; f = 1 MHz.
7. This option available only on S5232 with 1024 x 4 organization. For 512 x 8 organization, $V_{LL} = 0V$. For 1024 x 4 organization, $V_{LL} = 0V$ if R_{LL} is not programmed in; and $V_{LL} = -12V \pm 5\%$, if R_{LL} is programmed in. See output stage circuit options.
8. Outputs sinking 1.6mA or sourcing $-100\mu A$ and total load capacitance = 75pF.

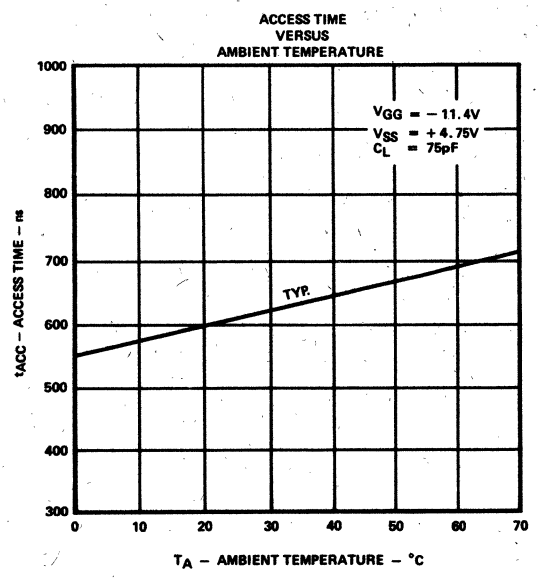
TIMING CHARACTERISTICS

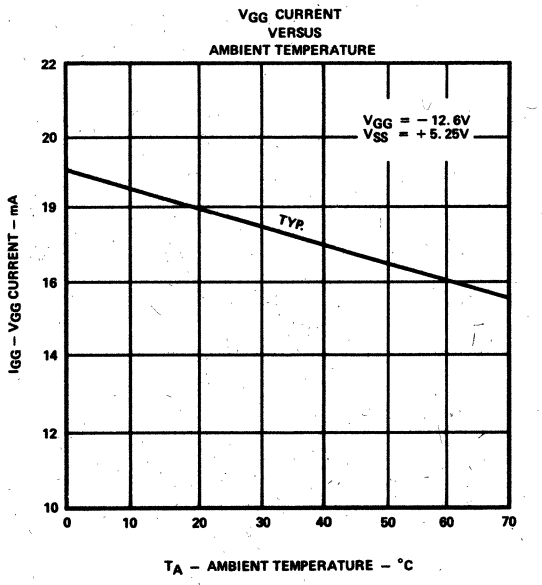


OPTIONAL INPUT PULL-UP CHARACTERISTICS



TYPICAL CHARACTERISTICS





MEMORY AMI

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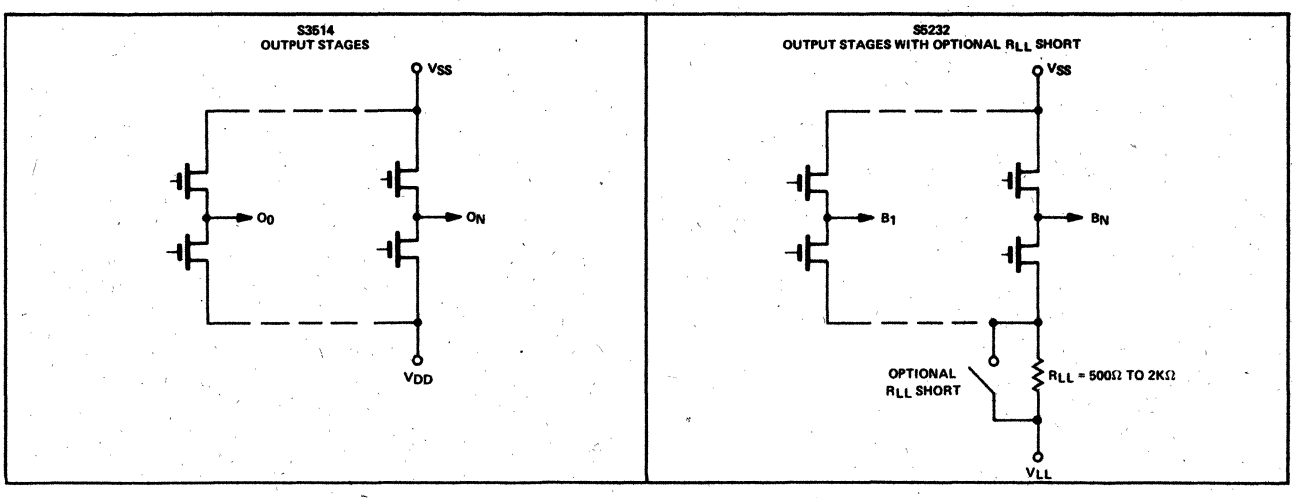
OUTPUT STAGE CIRCUIT OPTIONS



OPERATING MODE

S3514

Function	512 x 8	1024 x 4
Chip Select 0/A9	1 or 0	A9
Chip Select 1	1 or 0	1 or 0
Chip Select 2	1 or 0	1 or 0
Chip Select 3	1 or 0	1 or 0

1 = Most Positive = High Level Voltage

512 x 8: Chip Select 0/A9 operates as Chip Select 0.

1024 x 4: *A9 – Low enables odd outputs (O_1, O_3, O_5, O_7)
A9 – High enables even outputs (O_0, O_2, O_4, O_6)

*See note 9 on the following page.

Chip Selects: Four programmable chip selects provide control over 16-S3514 ROMS with no external decoding.

S5232

Function	512 x 8	1024 x 4
Mode Control	1	0
Chip Select 1	1 or 0	1 or 0
Chip Select 2	1 or 0	1 or 0
Chip Select 3/A10	1 or 0	address A10

1 = Most Positive = High Level Voltage

512 x 8: Mode Control – High
Chip Select 3/A10 operates as Chip Select 3.

1024 x 4. Mode Control – Low
*A10 – High enables even outputs (B_2, B_4, B_6, B_8)
A10 – Low enables odd outputs (B_1, B_3, B_5, B_7)

*See note 9 on the following page.

Chip Selects: Three programmable chip selects provide control over 8-S5232 ROMs with no external decoding.

AMI ROM PUNCHED–CARD CODING FORMAT[1]

First Card

Cols.	Information Field
1–30	Customer
31–50	Customer Part Number
60–72	AMI Part Number [2]

Second Card

1	Organization[3]
3	CS_0^4/A_9^8
5	CS3[4]
7	CS2[4]
9	CS1[4]
11	Active Pull-ups[5]

First Card

Cols.	Information Field
1–30	Customer
31–50	Customer Part Number
60–72	AMI Part Number [2]

Second Card

1	Organization[3]
3	CS_3^4/A_{10}^9
5	CS2[4]
7	CS1[4]
9	Active Pull-ups[5]
11	Series resistor to V_{LL}[6]

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AMI ROM PUNCHED–CARD CODING FORMAT[1] (Cont.)

S3514

Data Cards/512 x 8 Organization

1–4	Decimal Address
6–13	Output O7 – O0 (MSB thru LSB)
15–17	Octal Equivalent of output data[7]

Data Cards/1024 x 4 Organization

1–4	Decimal Address (0–1022) even addresses
6–9	Output (MSB–LSB)
11–12	Octal Equivalent of output data[7]
50–53	Decimal Address (1–1023) odd addresses
55–58	Output (MSB–LSB)
60–61	Octal Equivalent of output data[7]

S5232

Data Cards/512 x 8 Organization

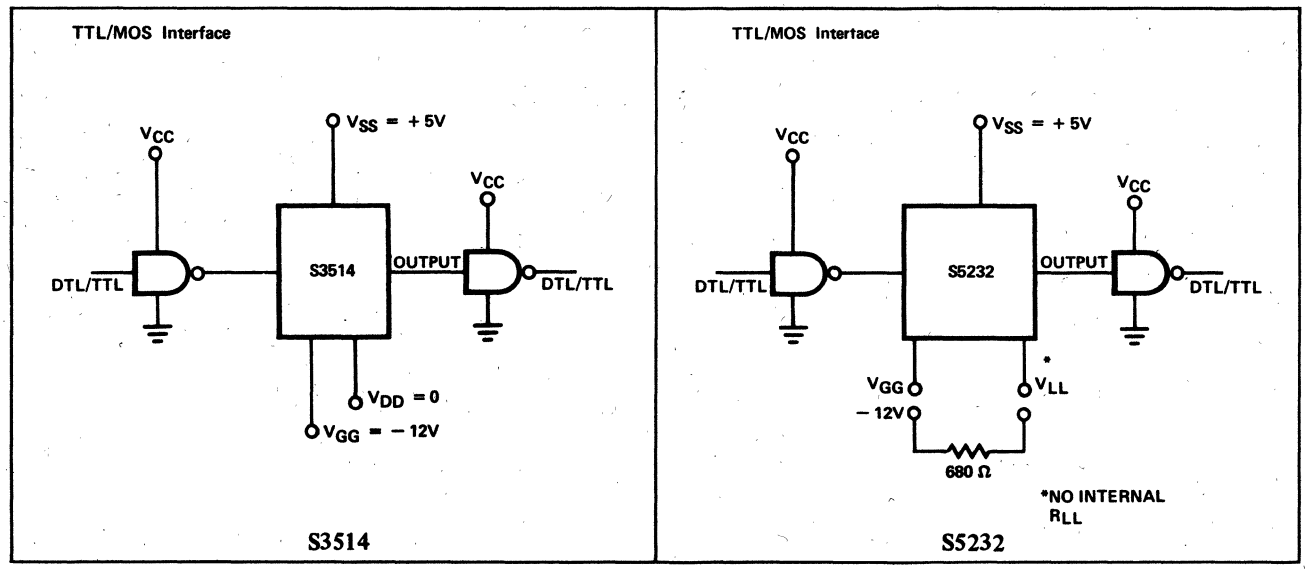
1–4	Decimal Address
6–13	Output B8–B1 (MSB thru LSB)
15–17	Octal Equivalent of output data[7]

Data Cards/1024 x 4 Organization

1–4	Decimal Address (0–1022) even addresses
6–9	Output (MSB–LSB)
11–12	Octal Equivalent of output data[7]
50–53	Decimal Address (1–1023) odd addresses
55–58	Output (MSB–LSB)
60–61	Octal Equivalent of output data[7]

NOTES:
1. Positive logic formats accepted only.
2. Assigned by Marketing Department; may be left blank.
3. A "0" indicates 512 x 8; a "1" indicates 1024 x 4.
4. A "0" indicates the chip is enabled by a logic 0, a "1" indicates it is enabled by a logic 1, and a "2" indicates a "Don't Care" condition.
5. A "1" indicates active pull-ups; a "0" indicates no pull-ups.
6. A "0" indicates an internal resistor, a "1" indicates no internal resistor. Available only with 1024 x 4 organization.
7. The octal parity check is created by breaking up the output word into groups of three from right to left and creating a base 8 (octal) number in place of these groups. For example the output word 10011110 would be separated into groups 10/011/110 and the resulting octal equivalent number is 236.
3. For 1024 x 4 organization, CSO/A9 input acts as A9 address. A9 LOW enables odd outputs; A9 HIGH enables even outputs. For this case, a "0" is required in this field. However, if it is required that A9 HIGH should enable odd outputs and A9 LOW should enable even outputs, a "1" may be punched in this field.
9. For 1024 x 4 organization, CS3/A10 acts as A10 address. A10 LOW enables odd outputs; and A10 HIGH enables even outputs. For this case, a "0" is required in this field. However, if it is required that A10 HIGH should enable odd outputs and A10 LOW should enable even outputs, a "1" may be punched in this field.

TYPICAL APPLICATION



*For applications where V_{GG} is connected to V_{LL}, where low power dissipation is required on outputs and where a constant external resistance is preferred, the internal resistor can be programmed out and an external 680Ω resistor can be connected as shown.

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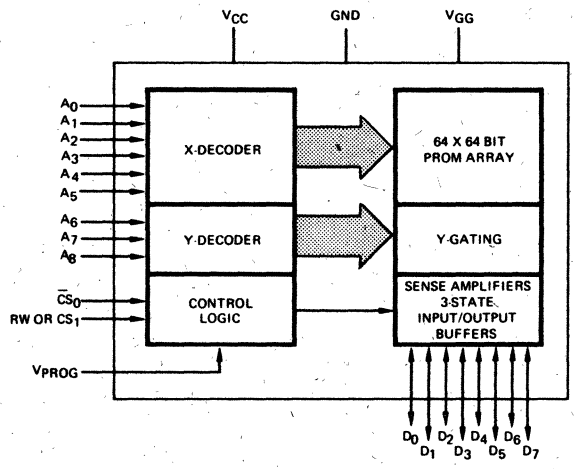
S5204A

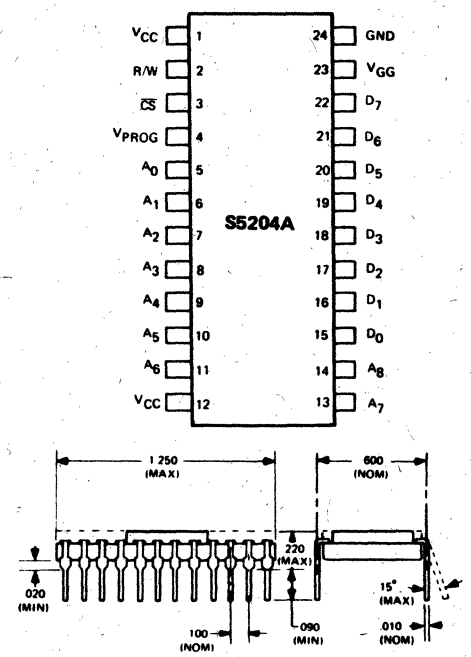
512 X 8 BIT
ERASABLE AND
ELECTRICALLY REPROGRAMMABLE
READ ONLY MEMORY

AMERICAN MICROSYSTEMS, INC.

ADVANCED PRODUCT DESCRIPTION



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- On-Board Programmability
- Fast Access Time – 750 ns Max.
- High Speed Programming – Less than 1 Minute for all 4096 Bits
- Programmed with R/W, CS and V_{PROG} Pins
- Completely TTL Compatible – Excluding the V_{PROG} Pin
- Ultraviolet Light Erasable – Less than 10 Minutes
- Static Operation – No Clocks Required
- Three-State Data I/O
- Standard Power Supplies +5V and –12V
- Mature P-Chan Process

FUNCTIONAL DESCRIPTION

The S5204A is a high speed, static, 512 x 8 bit, erasable and electrically programmable read only memory designed for use in bus-organized systems. Both input and output are TTL compatable during both read and write modes. Packaged in a 24 pin hermetically sealed dual in-line package the bit pattern can be erased by exposing the chip to an ultra-violet light source through the transparent lid, after which a new pattern can be written.

TYPICAL APPLICATIONS

- Random Logic Replacement
- Programmable Waveforms
- Character Generation
- Electronic Keyboards
- ROM Program Debugging
- Code Translation
- Microprogramming
- Look-up Tables

ABSOLUTE MAXIMUM RATINGS

Voltage on any pin relative to V_{SS} except the V_{PROG} pin	+0.3 to –20V
Voltage on the V_{PROG} pin relative to V_{SS}	+0.3 to -60V
Operating Temperature	0°C to +70°C
Storage Temperature (programmed)	–55°C to +85°C
Storage Temperature (unprogrammed)	–55°C to 150°C

NOTE: This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields, however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high-impedance circuit.

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DC (STATIC) CHARACTERISTICS (V_{CC} = +5.0V ± 5%, V_{GG} = −12.0V ± 5% T_A = 0 − 70°C unless otherwise noted).

SYMBOL	CHARACTERISTIC	MIN	MAX	UNIT
V_{IL}	INPUT VOLTAGE LOW		0.8	V
V_{IH}	INPUT VOLTAGE HIGH	V_{CC} −2.25	V_{CC} +.3	V
V_{OL}	OUTPUT VOLTAGE LOW I_{OL} = 1.6 ma		0.4	V
V_{OH}	OUTPUT VOLTAGE HIGH I_{OH} = 40 μa	2.4		V
I_{LI}	INPUT LEAKAGE CURRENT		10	μa
I_{LO}	OUTPUT LEAKAGE CURRENT CS = 5V		20	μa
I_{GG}	V_{GG} SUPPLY CURRENT		45	ma
I_{CC}	V_{CC} SUPPLY CURRENT		50	ma
P_D	POWER DISSIPATION		750	mw

NOTE: Program input V_{PROG} may be tied to V_{CC} during the Read.

AC (DYNAMIC) CHARACTERISTICS (Loading is as shown in Figure 1 unless otherwise noted).

SYMBOL	CHARACTERISTIC	MIN	MAX	UNIT
T_{ACC}	ACCESS TIME		750	ns
T_{CO}	CHIP SELECT TO OUTPUT DELAY		400	ns
T_{DD}	CHIP DESELECT TO OUTPUT DELAY			ns

PROGRAM CHARACTERISTICS (R/W G_{nd}, Program pulse rise and fall time (10% to 90%) are both at 1μs max).

SYMBOL	CHARACTERISTICS	MIN	MAX	UNIT
T_{AS}	ADDRESS SET UP TIME	10		μs
T_{CSS}	CHIP SELECT SET UP TIME	10		μs
T_{DS}	DATA SET UP TIME	10		μs
T_{AH}	ADDRESS HOLD TIME	10		μs
T_{CSH}	CHIP SELECT HOLD TIME	10		μs
T_{DH}	DATA HOLD TIME	10		μs
T_{PWL}	PROGRAM PULSE WIDTH LOW	3	5	ms
T_{PWH}	PROGRAM PULSE WIDTH HIGH	500		μs
V_{PROG}	PROGRAM AMPLITUDE	−55	−50	V
I_{PROG}	PROGRAM CURRENT		35	ma
T_{WS}	WRITE SET UP TIME	10		μs
T_{WH}	WRITE HOLD TIME	5		μs
T_{RS}	READ SET UP TIME	10		μs

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INTERFACE DESCRIPTION

Pin	Label	Function
(15)	D0	**Data Lines** – with the R/W line selected for Read (V_{IH}), the Data Line (D0 through D7) are set to reflect the contents of the selected memory location. When the R/W line is set for Write (V_{IL}), the Data Lines are stored at the addressed location of the 5204A when V_{PROG} is present. The Data Bus output drivers are three-state devices that remain in the high impedance (off) state whenever CS is in the V_{IH} state or when R/W is in the V_{IL} state.
(16)	D1	
(17)	D2	
(18)	D3	
(19)	D4	
(20)	D5	
(21)	D6	
(22)	D7	
(2)	R/W	**Read/Write** – When this input line is set to V_{IH}, the device is in the Write mode, a low (V_{IL}) signal puts it into the Read mode.
(3)	CS	**Chip Select** – This input line must be set to V_{IL} for a Read or Write operation to be performed. When it is High (V_{IH}) the output data bus is set to a high-impedance three-state condition.
(4)	V_{PROG}	**Program** – In the Write mode, a 50Volt programming pulse at this input causes the data at the Data Lines to be stored in the selected address location. This pin should be tied to V_{CC} for normal Read operations.
(5)	A0	**Address Lines** – These lines select the 8 bit word in memory for Read or Write operation.
(6)	A1	
(7)	A2	
(8)	A3	
(9)	A4	
(10)	A5	
(11)	A6	
(13)	A7	
(14)	A8	

CONTROL FUNCTION TRUTH TABLE

CS	R/W	V_{PROG}	MODE	OUTPUTS
0	1	V_{PROG}	Write	Active Data Inputs
0	0	V_{CC}	Read	Active
1	X	X	Standby	Floating

OPERATION

Initially, and after each erasure, all bits of the 5204A are in the LOW state (output 0 volts). Data is stored by selectively programming a HIGH into the desired bit locations. The R/W input (pin 2) is used to select the desired mode of operation. When the R/W input is HIGH the chip is in the write enable mode of operation. The outputs ($D_0 - D_7$) are disabled (floating) with the corresponding pins becoming the data inputs. The word address is selected in the same manner as in the Read mode. Data to be programmed is presented 8 bits in parallel and after the address and data are set up a programming pulse (V_P = - 50 volts) is applied. V_{PROG} electrically writes the data into the memory array. Writing may be inhibited by deselecting the chip with the CS input at a HIGH during the write cycle. This feature allows true "on board" programming in bus organized systems where the R/W and V_{PROG} inputs are common and the device to be programmed is selected by means of the chip select input as during read operations.

The amount of program energy required to insure memory retention may be defined as a function of the number of program pulses (N) times the program pulse width (t_{pw}) ($N \times t_{pw} \geq 60$ msec). This means if a 3 ms pulse is used, 20 program pulses are required, and if a 5 ms pulse is used 12 program pulses are required.

The read operation is accomplished by a LOW at the R/W input with the program input connected to V_{SS} potential. True data (data out = date in) is valid after the address is stable. The CS input will disable (float) the outputs when HIGH to allow capability with bus organized systems.

Erasure is accomplished by exposing the array to a 2537Å ultra-violet light source (such as Ultra-Violet Products, Inc. Lamp Model S52 or UVS-54, Turner Designs PROM Eraser, Model 30 or equivalent) for a period of 7 to 10 minutes. The clear optical lid should be approximately one inch away from the lamp tubes.

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FIGURE 1 — TEST CONDITIONS

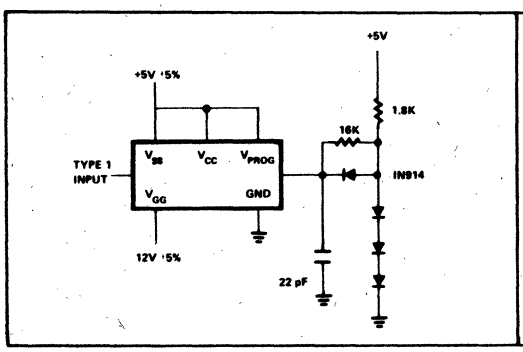


FIGURE 2 — READ CYCLE TIMING WAVEFORMS

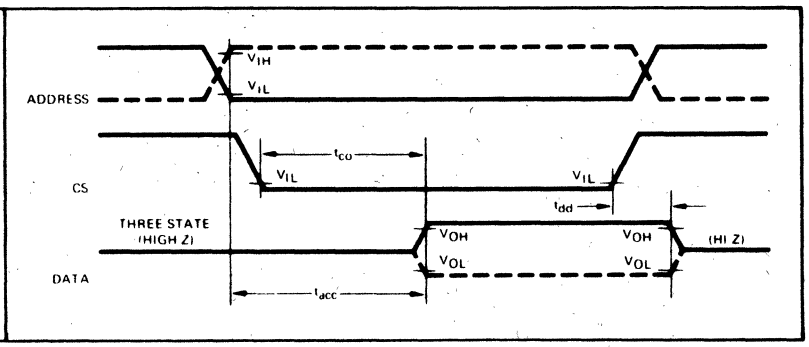


FIGURE 3 — PROGRAMMING CYCLE TIMING WAVEFORMS

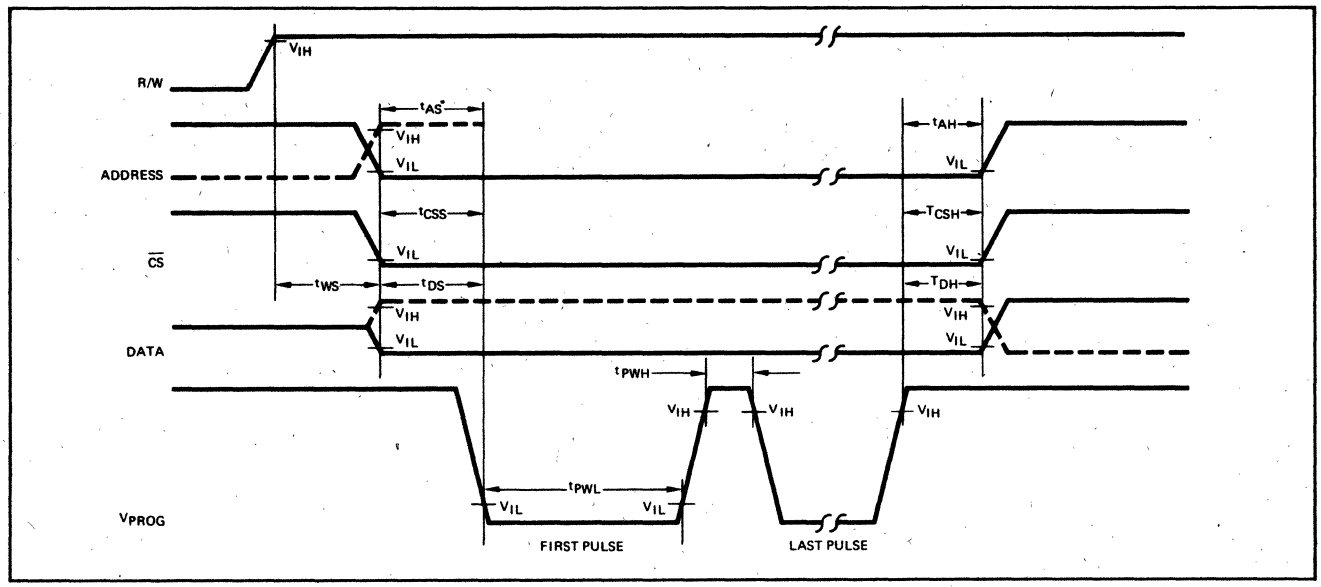
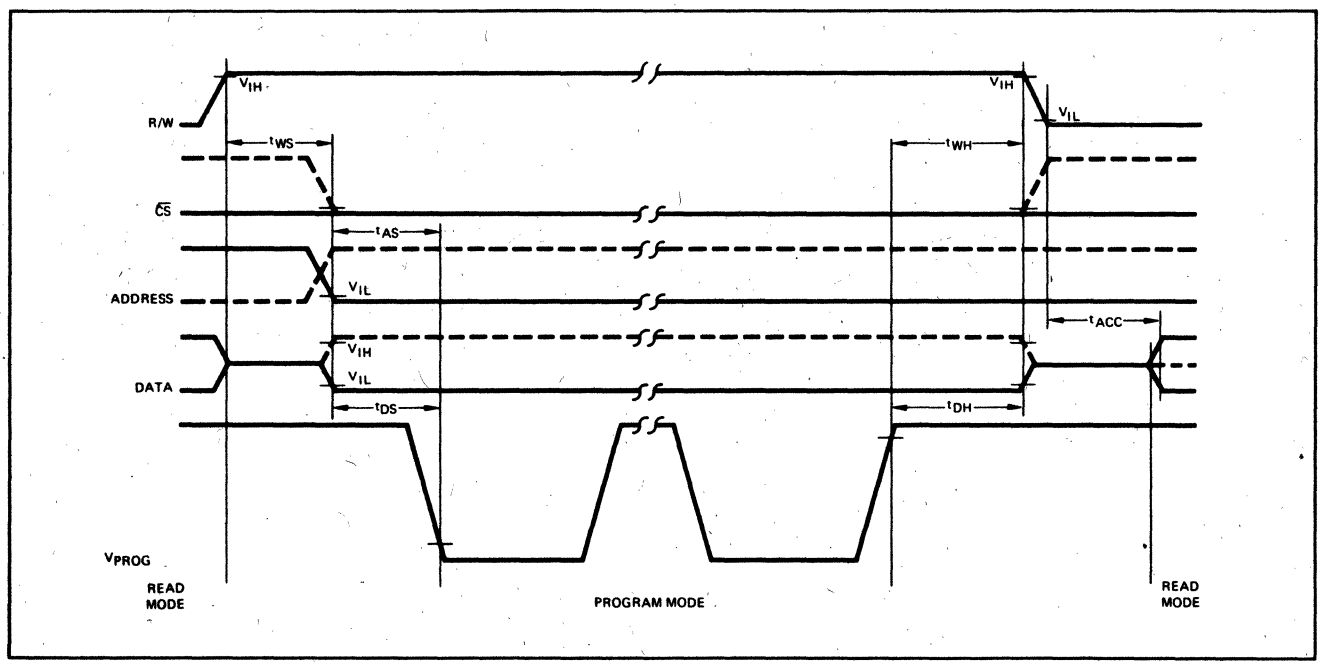


FIGURE 4 — READ/PROGRAM/READ CYCLE TIMING WAVEFORM



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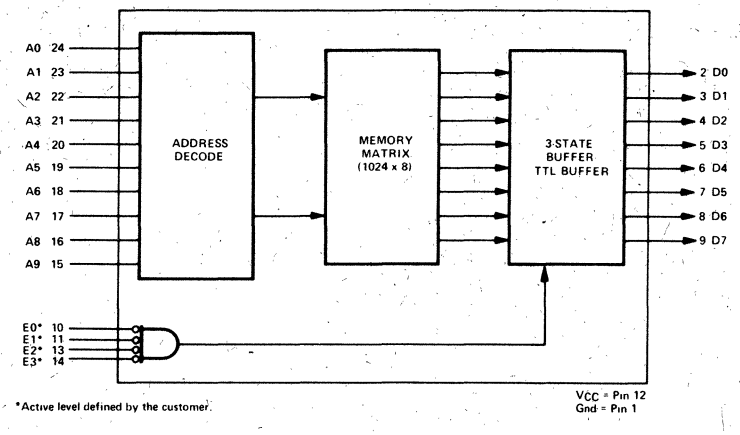
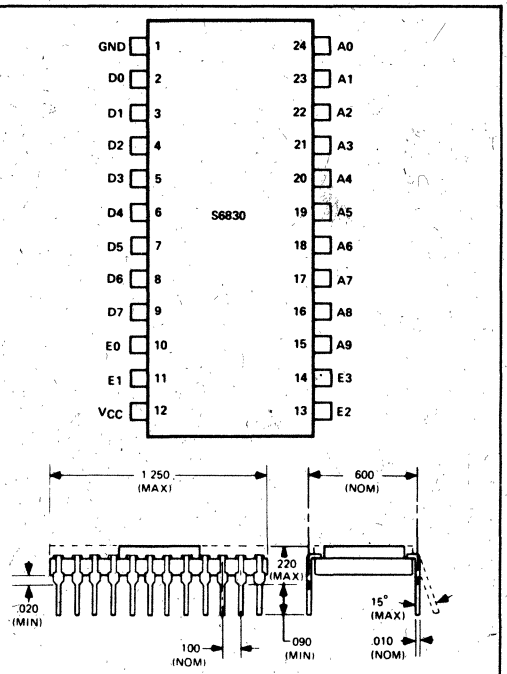
AMERICAN MICROSYSTEMS, INC.

S6830

1024 X 8
READ ONLY MEMORY



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- Organized as 1024-Bytes of 8 Bits
- Static Operation
- Three-State Data Output
- Four Chip Enable Inputs (Mask Programmable)
- Single 5-Volt Power Supply
- TTL Compatible Input/Output
- Maximum Access Time = 575 ns

FUNCTIONAL DESCRIPTION

The S6830 is a mask programmable read only memory organized 1024 words x 8 bits for application in byte organized systems. The S6830 is totally bus compatible with the S6800 microprocessor. Interfacing to the S6830 consists of an 8 bit three-state data bus, four mask programmable chip selects and ten address lines.

The S6830 is a totally static memory requiring no clocks. Access time is compatible with maximum data rates in a S6800 microprocessor system. The device operates from a single +5 volt power supply and is fabricated with N channel silicon gate technology.

ABSOLUTE MAXIMUM RATINGS (See Note 1)

Supply Voltage V_{CC}	-0.3 to +7.0V
Input Voltage V_{in}	-0.3 to +7.0V
Operating Temperature Range T_A	0 to +70°C
Storage Temperature Range T_{stg}	-55 to +150°C

NOTE: 1. Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended voltages for extended periods of time could affect device reliability.

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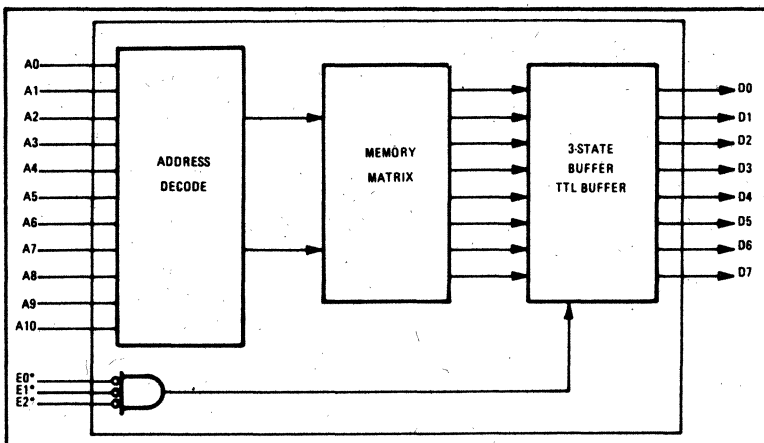
S6831/A/B/C

2048 X 8
READ ONLY MEMORY

AMERICAN MICROSYSTEMS, INC.

ADVANCED PRODUCT DESCRIPTION



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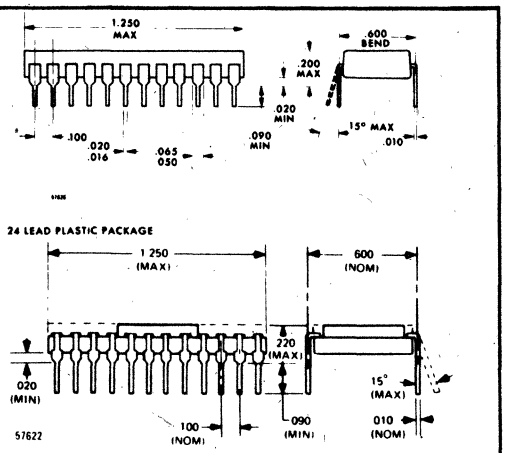
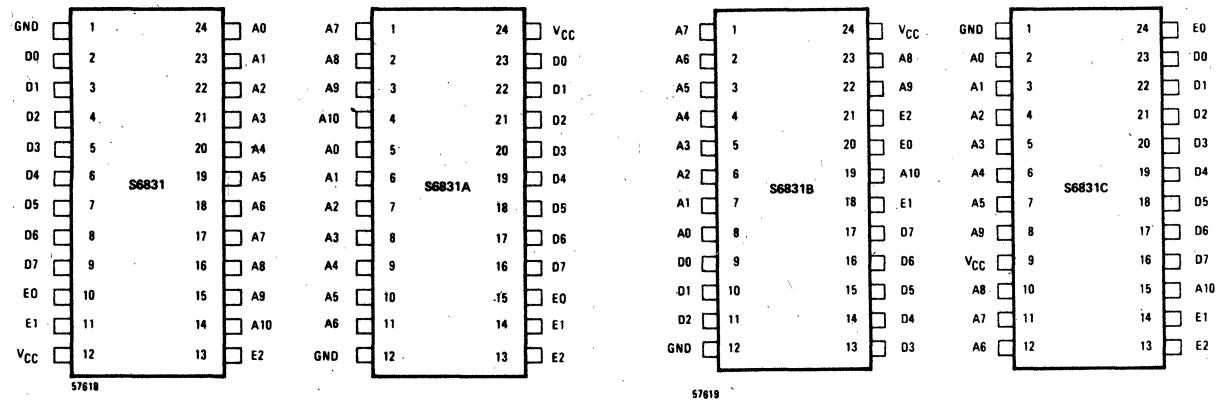


PIN/PACKAGE CONFIGURATION



- Maximum Access Time = 450 ns @ C_L = 130 pF
- Low Power 150 mW avg.
- Organized as 2048-Bytes of 8 Bits
- Static Operation
- Three-State Data Output
- 3 Chip Enable Inputs (Mask Programmable)
- The S6831 is pinout similar with the S6830
- The S6831A is pinout compatible with the 2316A, 8316A
- The S6831B is pinout compatible with the Intel 2316B, MC68317
- The S6831C is pinout compatible with the EA4600
- Single 5-Volt Power Supply
- TTL Compatible Input/Output

FUNCTIONAL DESCRIPTION

The S6831/A/B/C is a 16,384 bit Read Only Memory organized 2K words x 8 bits. This ROM has been designed to supply large bit storage, high performance memory for microprocessors and other demanding applications with simple interface requirements. The device will operate from a single +5V supply and is manufactured with a N-channel silicon gate depletion load technology. This device is available in all common high density ROM pinouts.

ABSOLUTE MAXIMUM RATINGS (See Note 1)

Supply Voltage V_{CC}	- 0.5 to + 7.0V	Operating Temperature Range T_A	0 to + 70°C
Input Voltage V_{in}	- 0.5 to + 7.0V	Storage Temperature Range T_{stg}	- 55 to + 150°C

NOTE 1 Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended voltages for extended periods of time could affect device reliability.

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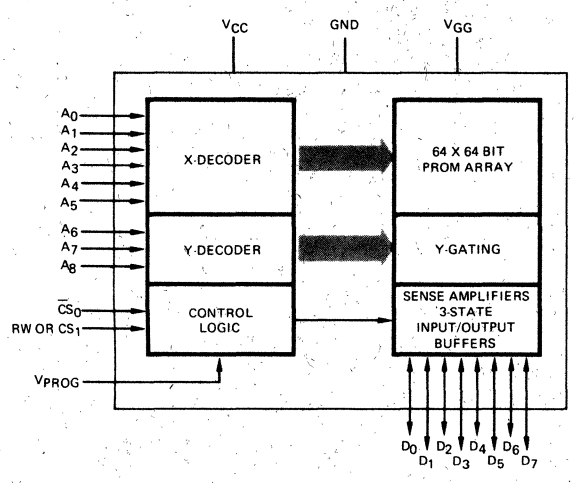
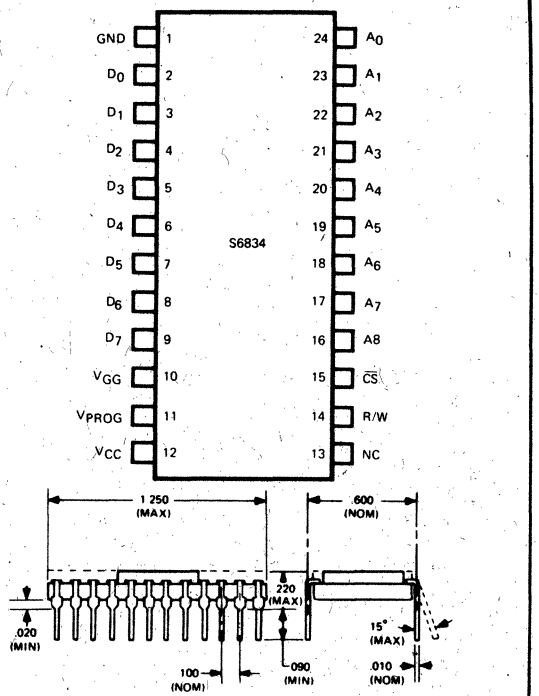
S6834

512 X 8 BIT ERASEABLE AND ELECTRICALLY REPROGRAMMABLE READ ONLY MEMORY



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- On-Board Programmability
- Fast Access Time – 500 ns Typ.
- Pin Configuration Similar to the S6830 1K x 8 Bit ROM
- High Speed Programming – Less than 1 Minute for all 4096 Bits
- Programmed with R/W, CS and V_{PROG} Pins
- Completely TTL Compatible – Excluding the V_{PROG} Pin
- Ultraviolet Light Erasable – Less than 10 Minutes
- Static Operation – No Clocks Required
- Three-State Data I/O
- Standard Power Supplies +5V and –12V
- Mature P-Chan Process

FUNCTIONAL DESCRIPTION

The S6834 is a high speed, static, 512 x 8 bit, eraseable and electrically programmable read only memory designed for use in bus-organized systems. Both input and output are TTL compatable during both read and write modes. Packaged in a 24 pin hermetically sealed dual in-line package the bit pattern can be erased by exposing the chip to an ultra-violet light source through the transparent lid, after which a new pattern can be written.

TYPICAL APPLICATIONS

- ROM Program Debugging
- Code Translation
- Microprogramming
- Look-up Tables
- Random Logic Replacement
- Programmable Waveforms
- Character Generation
- Electronic Keyboards

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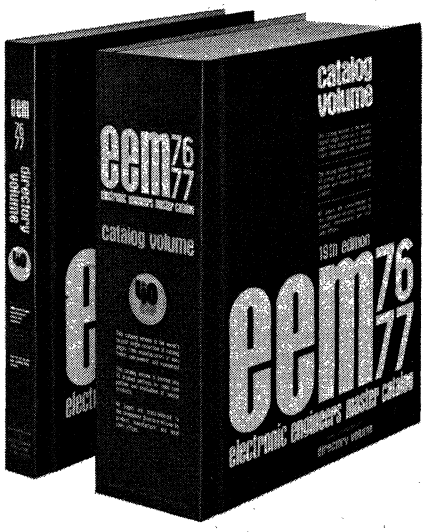

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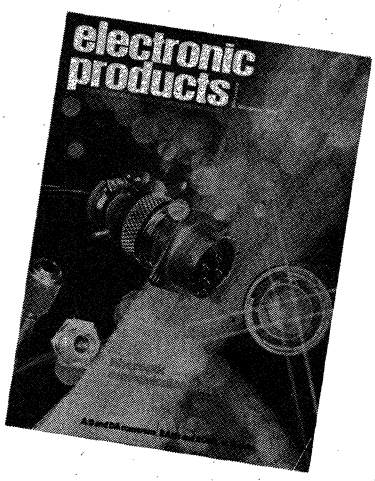

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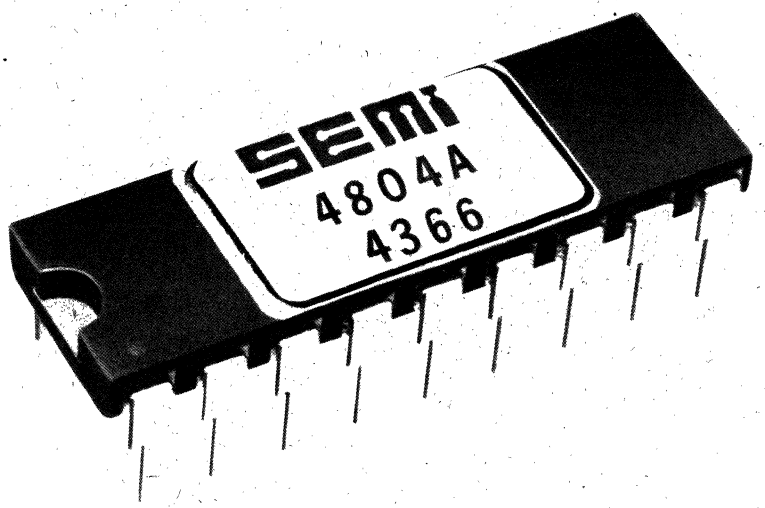
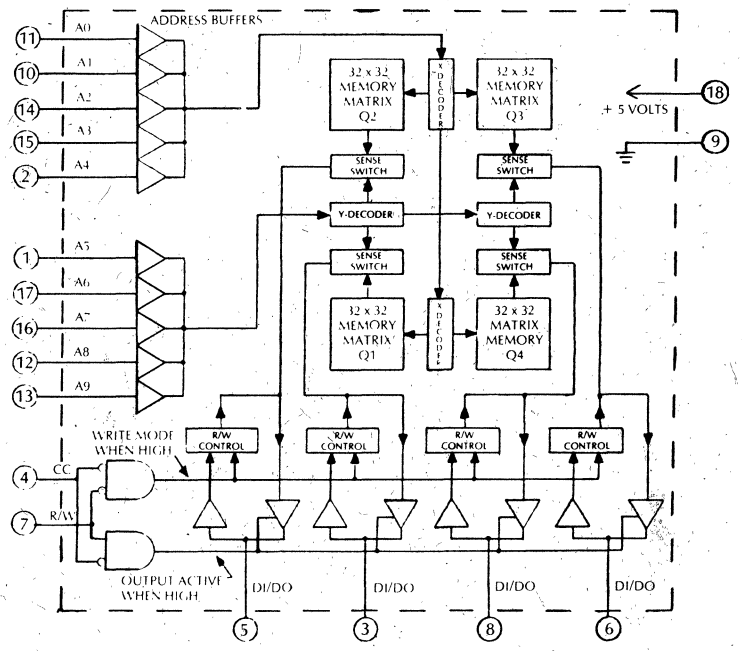
1024x4 **N-MOS RAM**



FEATURES

- ☐ SINGLE +5V POWER SUPPLY
- ☐ 1K x 4 ORGANIZATION
- ☐ REPLACES 4 1024x1 STATIC RAMS
- ☐ COMPLETELY STATIC — NO CLOCKS OR REFRESH
- ☐ 18 PIN PACKAGE
- ☐ 450 NSEC CYCLE TIME
- ☐ 250 MW TYPICAL OPERATING POWER
- ☐ COMMON I/O BUS
- ☐ TTL COMPATIBLE I/O
- ☐ THREE-STATE OUTPUTS
- ☐ FULLY DECODED CHIP

BLOCK DIAGRAM



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RECOMMENDED OPERATING CONDITIONS

T_{AMB} = 0°C to 70°C

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	V_{CC}	4.75	5.0	5.25	Vdc
Input High Level	V_{IN}	2.4	—	V_{CC}	Vdc
Input Low Level	V_{IL}	−0.5	—	0.8	Vdc

ABSOLUTE MAXIMUM RATINGS

(See Note 1) (Referenced to GND)

Rating	Value	Unit
Voltage On Any Pin With Respect To GND	−0.5 to +7	VDC
Power Dissipation	1.6 (Note 2)	W
Operating Ambient Temperature Range	0 to +70	°C
Storage Temperature	−65 to +150	°C

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.

NOTE 1: Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended or maximum voltages for extended periods of time could affect device reliability. NOTE 2: At 25°C ambient. Derate 13.5m w/°C.

DC ELECTRICAL CHARACTERISTICS

(Full Operating voltage & temperature range unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit	Conditions
Input Leakage Current	I_{LI}	-10	—	+10	μA	V_{IN} = 0.5V or +5V
Output Leakage Current	I_{LO}	−10	—	+10	μA	V_{OUT} = 2.4V
Output Voltage High	V_{OH}	2.4	—	V_{CC}	Vdc	I_{OH} = 200μa
Output Voltage Low	V_{OL}	—	—	0.5	Vdc	I_{OL} = 2.0ma
Power Supply Current	I_{CC}	—	45	75	—	V_{CC} = 5V; 25°C
	I_{CC}	—	65	100	ma	V_{CC} = 5V; 70°C

READ CYCLE

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Read Cycle Time	t_{RC}	450	—	—	ns	Full Operating Voltage and Temperature Range
Access Time	t_A	—	—	450	ns	
Chip Selection To Output Valid	t_{CO}	—	—	150	ns	
Data Valid After Address	t_{OH1}	100	—	—	ns	
Previous Data Valid After Chip De-Select	t_{OH2}	25	—	—	ns	

WRITE CYCLE

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Write Cycle Time	t_{WC}	450	—	—	ns	Full Operating Voltage and Temperature Range
Address To Write Time	t_{AW}	75	—	—	ns	
Write Pulse Width	t_{WP}	375	—	—	ns	
Write Recovery Time	t_{WR}	0	—	—	ns	
Data Set-Up Time	t_{DW}	250	—	—	ns	
Data Hold Time	t_{DH}	0	—	—	ns	
Output Disable From Write or Chip Enable	t_{OTW}	—	—	125	ns	

CAPACITANCE

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Input Capacitance	C_{IN}	—	—	5	pF	V_{IN} = 2.4V
Output Capacitance	C_{OUT}	—	—	10	pF	

4804 TIMING DIAGRAM

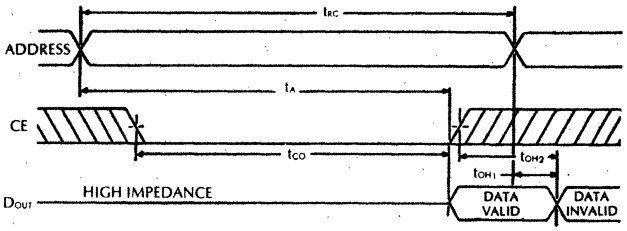

Figure 1 — READ CYCLE①

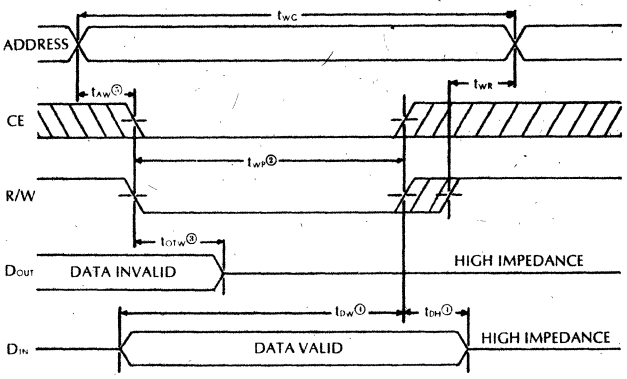

Figure 2 — WRITE CYCLE

NOTES:

1 R/W is high during read cycle.
2 t_{WP} is measured from the latter of CE or R/W going low to the earlier of CE or R/W going high.
3 t_{OTW} is measured from R/W going low or CE going high, whichever occurs first.
4 t_{DH} & t_{DW} are measured from the first of CE or R/W going high.
5 t_{AW} is measured with respect to R/W only.
6 Capacitive loading to simulate effect of four additional outputs plus one TTL input.
7 Input pulse levels .....0.8 volt to 2.4 volts.
8 Input rise and fall times .....10 nsec.
9 Input and output timing levels .....1.5 volts.

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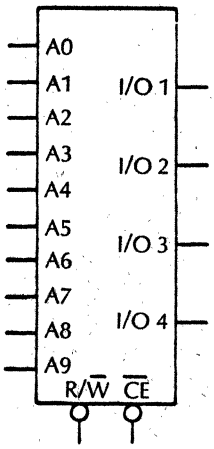
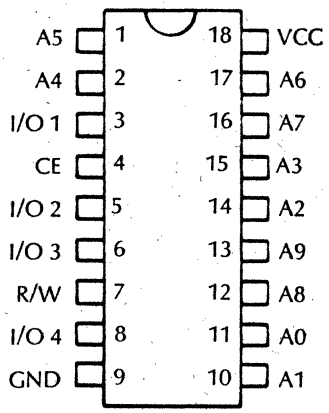
LOGIC SYMBOL



PIN CONFIGURATION

4804A



TRUTH TABLE

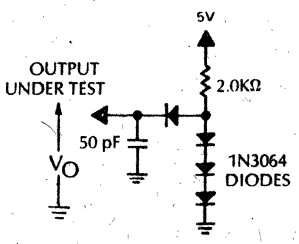
$\overline{CE}$	R/$\overline{W}$	DI/DO	STATUS	MODE
H	DON'T CARE	HIGH Z	DESELECT	STANDBY
L	H	DATA	SELECTED	READ
L	L	L	SELECTED	WRITE "0"
L	L	H	SELECTED	WRITE "1"

The EMM/SEMI 4804A is a 4096-bit static Random Access Memory organized as 1024 words by 4-bits using N-channel Metal-Gate MOS technology. It uses fully DC stable (static) circuitry throughout — in both the array and the decoding — and therefore requires no clocks or refreshing to operate. Data access is particularly simple since address setup times are not required. The data is read out non-destructively and has the same polarity as the data input. Common input/output pins are provided. A separate Chip Enable (CE) lead allows easy selection of an individual package when outputs are wire-ored.

When R/W is high, the data input buffers are inhibited to prevent erroneous data from getting into the array. As long as R/W remains high, the data stored cannot be affected by the address, Chip Enable, or data I/O voltage levels and timing transitions. The block diagram also shows data storage cannot be affected by R/W, the addresses, nor the I/O ports as long as CE is high. Either CE or R/W by itself — or in conjunction with the other — can prevent extraneous writing due to signal transitions.

Data within the array can only be changed during a Write time — defined as the overlap of CE low and R/W low. To prevent the loss of data, the addresses must be properly established during the entire Write time plus t_{AW}.

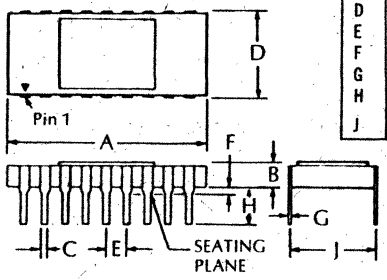
While it is important that the addresses remain stable for the entire Write cycle, the data inputs are not required to remain stable. Appropriate voltage levels will be written into the cells as long as the data is stable for t_{DW} at the end of the Write time.



Test Output Load

*Capacitive loading to simulate effect of four additional outputs plus one TTL input

Package Dimensions



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	22.61	23.11	0.890	0.910
B	—	2.67	—	0.105
C	0.38	0.53	0.015	0.021
D	7.06	7.57	0.278	0.298
E	2.29	2.79	0.090	0.110
F	0.64	1.14	0.025	0.045
G	0.20	0.30	0.008	0.012
H	3.43	3.94	0.135	0.155
J	7.62 REF		0.300 REF	

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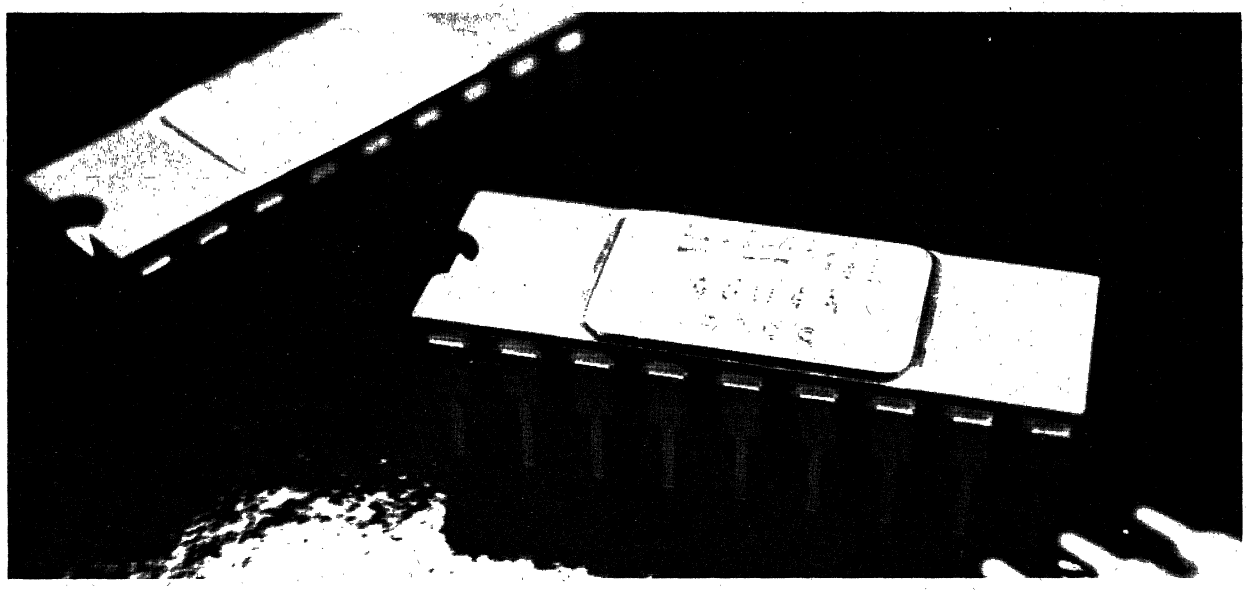

WARNING:

MOS CIRCUITS ARE SUBJECT TO DAMAGE FROM STATIC DISCHARGE

Internal static discharge circuits are provided to minimize part damage due to environmental static electrical charge build-ups. Industry established recommendations for handling MOS circuits include:

1. Ship and store product in conductive shipping tubes or in conductive foam plastic. Never ship or store product in non-conductive plastic containers or non-conductive plastic foam material.
2. Handle MOS parts only at conductive work stations.
3. Ground all assembly and repair tools.

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EMM SEMI

A Subsidiary of Electronic Memories & Magnetics Corp.
3883 North 28th Avenue, Phoenix, Arizona 85017
Telephone: (602) 263-0202

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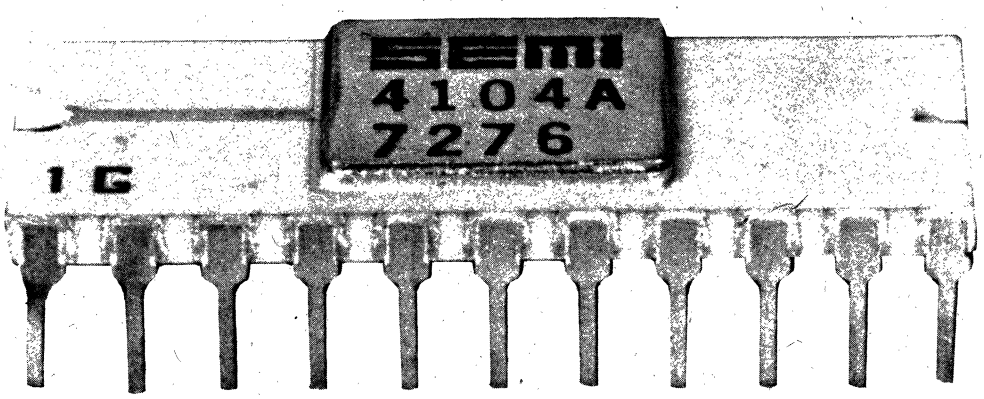
SEMI 4104 A

200 NSEC, STATIC, IN/ OUT

1024x4 **N-MOS RAM**



FEATURES

- ☐ 200 NSEC ACCESS, 350 NSEC CYCLE
- ☐ STATIC – NO REFRESH REQUIRED
- ☐ TTL COMPATIBLE INPUTS/OUTPUTS
- ☐ ON CHIP ADDRESS REGISTER
- ☐ 1Kx4 ORGANIZATION IDEAL FOR MICROPROCESSOR APPLICATIONS
- ☐ LOW OPERATING POWER 450 MW TYP
- ☐ LOW STANDBY POWER 35 MW TYP
- ☐ DATA RETENTION MODE, VDD=4V; VBB=4V
- ☐ STANDARD 22 PIN DIP
- ☐ NON-INVERTED DATA OUTPUT
- ☐ VOLTAGE COMPATIBLE WITH POPULAR MICROPROCESSORS

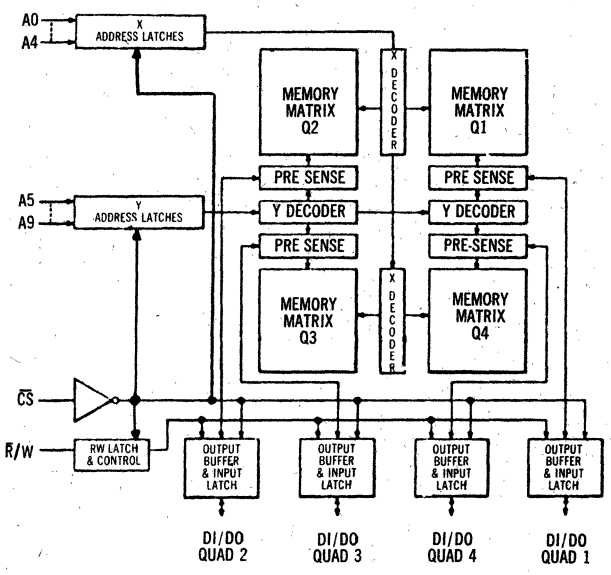
The SEMI 4104 is an N-Channel MOS Random Access Memory, organized as 1024 words by four bits. It uses a fully static memory cell which eliminates the need for any refresh or charge pump circuitry. All inputs can be driven by standard TTL devices and the three state data output can directly drive one TTL load of any type.

The Chip Select input provides for simple memory expansion and low system power, by putting unselected devices into a high output impedance and low power state. For additional power savings V_{DD} can be reduced significantly, thus allowing data to be retained economically under battery power.

Use of well-established technologies and conservative design rules, together with a 100 percent dynamic burn-in program results in the high reliability of the 4104 RAM.

The 4104 uses the same technology as used in the popular SEMI 4402/4200 series of STATIC RAM memories that have been in production since March 1975.

BLOCK DIAGRAM



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RECOMMENDED OPERATING CONDITIONS T_{AMB} = 0°C to 70°C

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	V_{DD}	11.4	12.0	12.6	Vdc
Output Reference Voltage	V_{CC}	4.75	5.0	5.25	Vdc
Substrate Voltage	V_{BB}	−4.5	−5	−5.5	Vdc
Input High Level	V_{IH}	2.4	—	5.25	Vdc
Input Low Level	V_{IL}	−0.5	—	0.7	Vdc
Chip Select High Level	V_{CH}	8	12	15	Vdc
Chip Select Low Level	V_{CL}	−0.5	—	0.5	Vdc

DC ELECTRICAL CHARACTERISTICS

(Full Operating Voltage and Temperature Range Unless Otherwise Noted)

Characteristics		Symbol	Min	Typ	Max	Unit	Conditions
Input Current		I_{IN}	−20	—	+20	μA	V_{IN} = 0.5V or 5.0V
Chip Select Input Current		I_{CS}	−20	—	+20	μA	V_{CS} = 0.5V or 12V
Output "Low" Voltage		V_{OL}	—	0.3	0.5	Vdc	I_O = 2.0mA Fig. 6
Output "High" Voltage		V_{OH}	2.7	3.5	V_{CC}	Vdc	I_O = 500 μA Fig. 6
Output Current (Unselected)		I_{DO}	−20	—	+20	μA	V_O = 2.7V, V_{CS} = +12V
Supply Current (Selected and Averaged over one cycle) CSW = 200 nsec TC = 350 nsec		I_{DD}	—	36	50	mA	V_{DD} = +12V V_{CC} = +5V V_{BB} = −5V T_{AMB} = 25°C
Supply Current (Unselected)	T_{AMB} = 25°C	I_{DDU}	—	2	5	mA	V_{DD} = +12V V_{CC} = +5V
	T_{AMB} = 70°C	I_{DDU}	—	4.5	15	mA	
Substrate Current V_{CS} = 0V		I_{BB}	—	2.2	−3	mA	V_{BB} = −5V
Reference Supply Current		I_{CC}	—	50	100	μA	V_{CS} = 12V
Standby Current at Reduced Voltages	T_{AMB} = 25°C	I_{DDS}	—	0.8	2	mA	V_{CS} = 4V to 12V V_{DD} = 4V V_{BB} = −4V V_{CC} = 0V
	Voltages T_{AMB} = 70°C	I_{DDS}	—	1.8	6	mA	

AC ELECTRICAL CHARACTERISTICS

(Full Operating Voltage and Temperature Range Unless Otherwise Noted)

Characteristics	Symbol	Min	Typ	Max	Unit	Figure
Chip Select Read Pulse Width	T_{CSR}	200	—	—	ns	1
Chip Select Write Pulse Width	T_{CSW}	200	—	—	ns	2
Chip Select Rise and Fall Time	T_{CR}, T_{CF}	—	10	100	ns	1&2
Set Up Time	T_P	0	—	—	ns	1&2
Access Time	T_A	—	—	200	ns	1
Cycle Time, T_{CR} = C_{CF} = 10ns (Read or Write)	T_C	350	—	—	ns	1&2
Data Hold Time	T_H	150	—	—	ns	1&2
Output Recovery Time	T_{DR}	10	15	—	ns	1
Read Recovery Time	T_{CRR}	125	—	—	ns	1
Write Recovery Time	T_{CWR}	125	—	—	ns	2

CAPACITANCE (Over Full Temperature Range and Worst Case Voltage Conditions)

Characteristics	Symbol	Min	Typ	Max	Unit	Conditions
Input Capacitance (Except Chip Select)	C_{IN}	—	4	6	pF	V_{IN} = 2.4V
Input Capacitance Chip Select	C_{CS}	—	6	10	pF	V_{CS} = 12V or 0V
Output Capacitance	C_O	—	6	8	pF	V_O = 2.7V V_{CS} = 12V

ABSOLUTE MAXIMUM RATINGS (See Note 1) (Referenced to GND)

Rating	Symbol	Value	Unit
Supply Voltages	V_{DD}	−.5 to +15	Vdc
	V_{CC}	−.5 to +7	Vdc
	V_{BB}	+.5 to −7	Vdc
Input & Output Voltages (Except Chip Select)	V_I, V_O	V_{BB} to +15	Vdc
Chip Select Input Voltage	V_{SC}	V_{BB} to +15	Vdc
Power Dissipation	P_D	1.6 (Note 2)	W
Operating Ambient Temperature Range	T_{AMB}	0 to +70	°C
Storage Temperature Range		−65 to +150	°C

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.

NOTE 1: Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended or maximum voltages for extended periods of time could affect device reliability.

NOTE 2: At 25°C ambient, Derate 13.5m w/°C.

TIMING DIAGRAMS

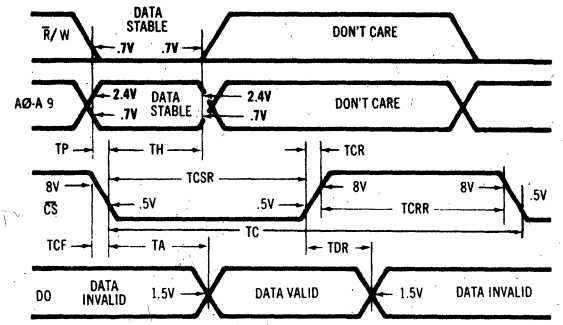

Figure 1 — Read Cycle

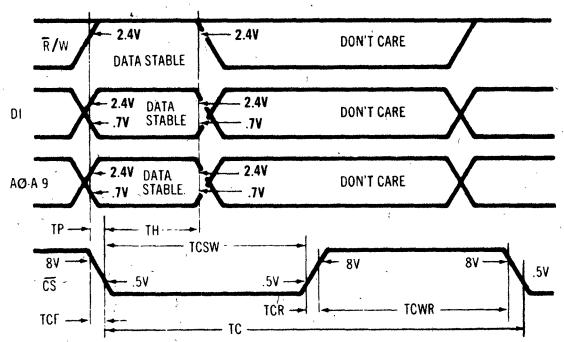

Figure 2 — Write Cycle

22 PIN DUAL IN-LINE

PIN	SYMBOL	FUNCTION
1	VBB	Supply Voltage (−5V)
2	A1	Address Input
3	AO	Address Input
4	DI/DO	Data Input/Data Output
5	A9	Address Input
6	A8	Address Input
7	A7	Address Input
8	DI/DO	Data Input/Data Output
9	R/W	Read/Write Input
10	VCC	Supply Voltage (+5V)
11	GND	Ground
12	NC	No Internal Connection
13	CS	Chip Select Input
14	A2	Address Input
15	A5	Address Input
16	A6	Address Input
17	DI/DO	Data Input/Data Output
18	DI/DO	Data Input/Data Output
19	A4	Address Input
20	A3	Address Input
21	NC	No Internal Connection
22	VDD	Supply Voltage (+12V)

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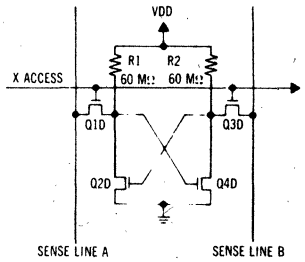


Figure 3 — Memory Cell

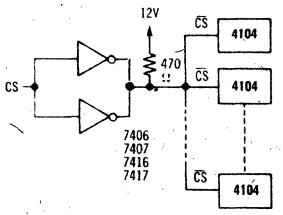


Figure 4 — Typical Chip Select Driver

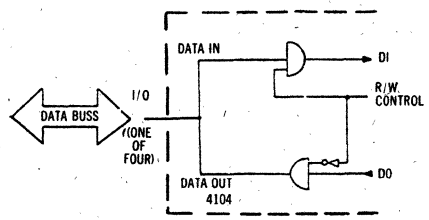
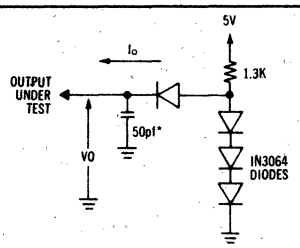
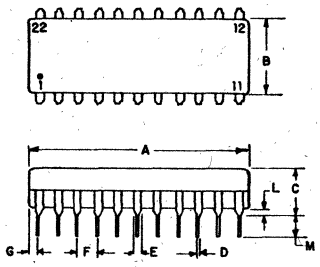


Figure 5 — Common Data I/O

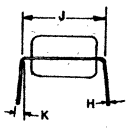


*Capacitance loading to simulate effect of seven additional outputs plus one TTL input

Figure 6 — Output Test Load



DIM	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.
A	25.4	29.72	1.000	1.17
B	8.64	9.14	.340	.360
C	4.32	5.08	.170	.200
D	.36	.56	.014	.022
E	.76	1.52	.030	.060
F	2.41	2.67	.095	.105
G	1.02	2.03	.040	.080
H	.20	.31	.008	.012
J	9.65	10.16	.380	.400
K	0°	15°	0°	15°
L	.51	1.02	.020	.040
M	2.54	3.56	.100	.140



PLASTIC PACKAGE DIMENSIONS

BASIC OPERATION

The 4096 static bits of memory are organized as four arrays of 32 rows by 32 columns. The memory cells are loaded or interrogated by simultaneously decoding the X address AO through A4 for the rows (see Block Diagram) and the Y address A5 through A9 for the columns. Each column contains a presense amplifier, the outputs of which are "OR-ed" and connected to the output TTL buffer. This is done in each of the four 1024 arrays and four separate data outputs are brought out in parallel. Each bit or memory cell is a standard flip flop consisting of R1, R2, Q2D, and Q4D with two access devices Q1D and Q3D (See Figure 3). The load resistors R1 and R2 are 60 megohms typical and connect to the VDD supply. Q1D and Q3D are used to connect the cell to the sense lines whenever the X access line is high. In the read mode the cell pulls one of the sense lines low from its normally high state. The selected presense circuit detects the differential voltage on the sense lines and amplifies it. In the write mode one sense line is forced low by the presense circuit and the selected cell assumes the state of the sense lines.

CHIP SELECT

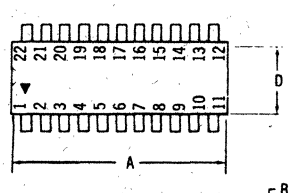
The Chip Select controls the operation of the memory. When the Chip Select input is high the input address buffers, decoders, sensing circuits and output stages are held in the "off" state and power is supplied only to the memory elements. When the Chip Select input is pulled low, the memory is enabled. The Chip Select negative going edge clocks the TTL logic level addresses, $\overline{R}/W$, and data input into "D" type flip flops, and enables the output stages.

COMMON DATA BUSS

Four common data I/O lines are provided, one for each data bit. Chip Select gates on a memory cycle and the $\overline{R}/W$ input determines whether a READ or a WRITE operation is to be performed. The $\overline{R}/W$ control also determines whether the common data I/O lines are to be used in an input or output data mode (Reference Figure 5). The input $\overline{R}/W$ signal is latched internally at the beginning of the Chip Select pulse and this latched signal provides the proper control to the common input/output lines during the active portion of the memory cycle. At the end of the Chip Select pulse, the output buffers are disabled and the common input/output lines revert to a high impedance state. This high impedance, disabled state allows "wire-or" connections to the common data I/O lines.

DATA OUTPUT

During a read operation when Chip Select goes low, output data will be presented within the specified access time and will remain until Chip Select goes high again. The output circuit is specified to drive any TTL series with good noise immunity at a fan-out of 1. Output data is non-inverted with respect to the input data.



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	27.1	27.8	1.065	1.095
B	—	3.56	—	0.140
C	0.38	0.53	0.015	0.023
D	8.64	10.8	0.340	0.425
E	2.29	2.79	0.090	0.110
F	0.51	1.27	0.020	0.050
G	0.20	0.30	0.008	0.012
H	3.42	3.93	0.135	0.155
J	10.2 REF		0.4 REF	

CERAMIC PACKAGE DIMENSIONS

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Battery Operation/Power Failure Data Retention
The memory cells (because they are cross coupled high impedance static cells) will retain data down to $V_{DD} = 4V$, $V_{BB} = -4V$.

Input Circuits — $\overline{R}/W$ Select, Data In and Address Input

The input signal is latched by Chip Select and can change after the specified hold time. The inputs can be driven from standard TTL gates. The input does not put any DC loading on the TTL driver.

$\overline{Read}$/Write Mode Select
To WRITE, the $\overline{R}/W$ Input should be high prior to Chip Select. To READ, the $\overline{R}/W$ Input should be low prior to Chip Select. When Chip Select goes low, $\overline{R}/W$ is latched into a register.

Data In
During a WRITE cycle the Data In (either high or low) should be stable prior to Chip Select. When Chip Select goes low, Data In is latched into a register.

Address
Addresses should be stable prior to Chip Select. When Chip Select goes low all addresses are latched into an Address Register.

ORDERING INFORMATION

Part Number	Access Time	Temperature Range	Package
4104ACC	200nsec	0°C to +70°C	22 Pin Ceramic
4104ACP	200nsec	0°C to +70°C	22 Pin Plastic

To order higher performance units or military grade parts, contact the factory direct.

WARNING:

MOS CIRCUITS ARE SUBJECT TO DAMAGE FROM STATIC DISCHARGE

Internal static discharge circuits are provided to minimize part damage due to environmental static electrical charge build-ups. Industry established recommendations for handling MOS circuits include:

1. Ship and store product in conductive shipping tubes or in conductive foam plastic. Never ship or store product in non-conductive plastic containers or non-conductive plastic foam material.
2. Handle MOS parts only at conductive work stations.
3. Ground all assembly and repair tools.

Represented in Your Area By:

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EMM SEMI
A Subsidiary of Electronic Memories & Magnetics Corp.
3883 North 28th Avenue, Phoenix, Arizona 85017
Telephone: (602) 263-0202

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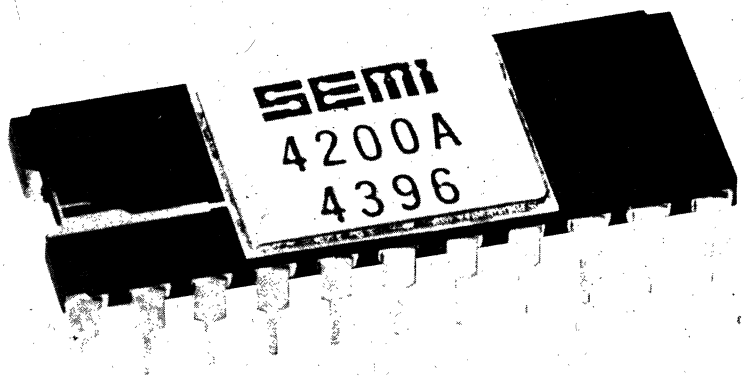
SEMI 4200A

200 NSEC STATIC, TTL IN/OUT

N-MOS RAM

4096x1



FEATURES

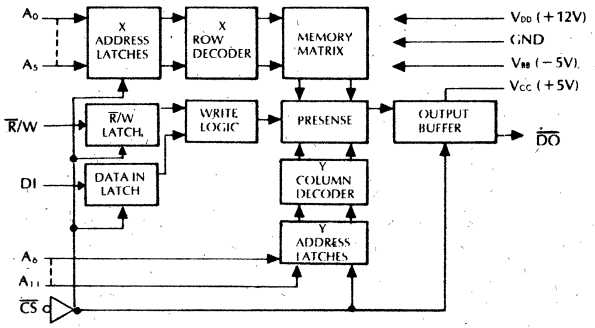
- ☐ COMPLETELY STATIC
- ☐ ACCESS TIME — 200 NSEC
- ☐ CYCLE TIME — 350 NSEC
- ☐ TYPICAL OPERATING POWER UNDER 450 mw.
- ☐ TYPICAL STANDBY POWER UNDER 35 mw.
- ☐ DATA RETENTION WITH LOW V_{DD}
- ☐ PIN AND VOLTAGE COMPATIBLE WITH STANDARD 22 PIN 4K DYNAMIC RAMS
- ☐ TTL COMPATIBLE THREE-STATE OUTPUTS
- ☐ FULLY DECODED
- ☐ ACTIVE LOW CHIP SELECT

The SEMI 4200 is an N-Channel MOS Random Access Memory, organized as 4096 words by one bit. It uses a fully static memory cell which eliminates the need for any refresh or charge pump circuitry. All inputs can be driven by standard TTL devices and the tri-state data output can directly drive one TTL load of any type.

The Chip Select input provides for simple memory expansion and low system power, by putting unselected devices into a high output impedance and low power state. For additional power savings V_{DD} can be reduced significantly, thus allowing data to be retained economically under battery power.

Use of well-established technologies and conservative design rules, together with a 100 percent dynamic burn-in program results in the high reliability of the 4200 RAM.

BLOCK DIAGRAM



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RECOMMENDED OPERATING CONDITIONS
T_{AMB} = 0°C to 70°C

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	V_{CD}	11.4	12.0	12.6	Vdc
Output Reference Voltage	V_{CC}	4.75	5.0	5.25	Vdc
Substrate Voltage	V_{BB}	−4.5	−5	−5.5	Vdc
Input High Level	V_{IH}	2.4	—	5.25	Vdc
Input Low Level	V_{IL}	−1	—	0.7	Vdc
Chip Select High Level	V_{CH}	8	12	15	Vdc
Chip Select Low Level	V_{CL}	−1	—	0.5	Vdc

DC ELECTRICAL CHARACTERISTICS
(Full Operating voltage & temperature range unless otherwise noted)

Characteristics		Symbol	Min	Typ	Max	Unit	Conditions
Input Current		I_{IN}	−20	—	+20	μA	V_{IN} =0.5V or 5.0V
Chip Select Input Current		I_{CS}	−20	—	+20	μA	V_{CS} = 0.5V or 12V
Output "Low" Voltage		V_{OL}	—	0.3	0.5	Vdc	I_O = 2.0mA Fig. 5
Output "High" Voltage		V_{OH}	2.7	3.5	V_{CC}	Vdc	I_O = 500 μA Fig. 5
Output Current (Unselected)		I_{DO}	−20	—	+20	μA	V_O = 2.7V, V_{CS} = +12V
Supply Current (Selected and Averaged over one cycle) CSW = 215 nsec TC = 215 nsec For Other Conditions, See Figure 3		I_{DD}	—	36	50	mA	V_{DD} = +12V V_{RF} = +5V V_{SX} = −5V T_{AMB} = 25°C
Supply Current (Uuselected)	T_{AMB} = 25°C	I_{DDU}	—	2	5	mA	V_{DD} = +12V
	T_{AMB} = 70°C	I_{DDU}	—	4.5	15	mA	V_{RF} = +5V
Substrate Current		I_{SX}	—	−2.2	−3	mA	V_{SX} = −5V
Reference Supply Current		I_{RF}	—	50	100	μA	V_{CS} = 12V
Standby Current at Reduced Voltage	T_{AMB} = 25°C	I_{DDS}	—	0.8	2	mA	V_{CS} = 4V to 15V V_{DD} = 4V V_{SX} = −5V ±10% V_{RF} = 0V
	Voltages T_{AMB} = 70°C	I_{DDS}	—	1.8	6	mA	

AC ELECTRICAL CHARACTERISTICS
(Full Operating voltage & temperature range unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit	Figure
Chip Select Read Pulse Width	T_{CSR}	200ns	—	—	ns	1
Chip Select Write Pulse Width	T_{CSW}	200ns	—	—	ns	2
Chip Select Rise and Fall Time	T_{CR}, T_{CF}	—	10	100	ns	1&2
Set Up Time	T_P	0	—	—	ns	1&2
Access Time	T_A	—	—	200	ns	1
Cycle Time, T_{CR} = T_{CF} = 10ns (Read or Write)	T_C	350	—	—	ns	1&2
Data Hold Time	T_H	100	—	—	ns	1&2
Output Recovery Time	T_{DR}	10	15	—	ns	1
Read Recovery Time	T_{CRR}	125	—	—	ns	1
Write Recovery Time	T_{CWR}	125	—	—	ns	2

CAPACITANCE
(Over Full Temperature Range and Worst Case Voltage Conditions)

Characteristics	Symbol	Min	Typ	Max	Unit	Conditions
Input Capacitance (Except Chip Select)	C_{IN}	—	4	6	pF	V_{IN} = 2.4V
Input Capacitance Chip Select	C_{CS}	—	6	10	pF	V_{CS} = 12V or 0V
Output Capacitance	C_O	—	6	8	pF	V_O = 2.7V V_{CS} = 12V

ABSOLUTE MAXIMUM RATINGS
(See Note 1) (Referenced to GND)

Rating	Symbol	Value	Unit
Supply Voltages	V_{DD}	−.5 to +15	Vdc
	V_{CC}	−.5 to +7	Vdc
	V_{BB}	+.5 to −7	Vdc
Input & Output Voltages (Except Chip Select)	V_I, V_O	V_{BB} to +15	Vdc
Chip Select Input Voltage	V_{CS}	V_{BB} to +15	Vdc
Power Dissipation	P_D	1.6 (Note 2)	W
Operating Ambient Temperature Range	T_{AMB}	0 to +70	°C
Storage Temperature Range	—	−65 to +150	°C

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.

NOTE 1: Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended or maximum voltages for extended periods of time could affect device reliability. NOTE 2: At 25°C ambient. Derate 13.5m w/°C.

TIMING DIAGRAMS

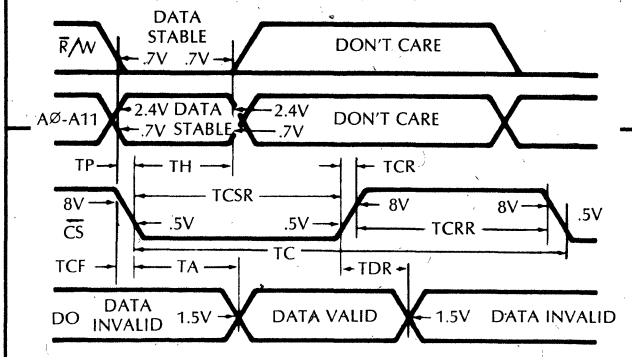


Figure 1 — Read Cycle

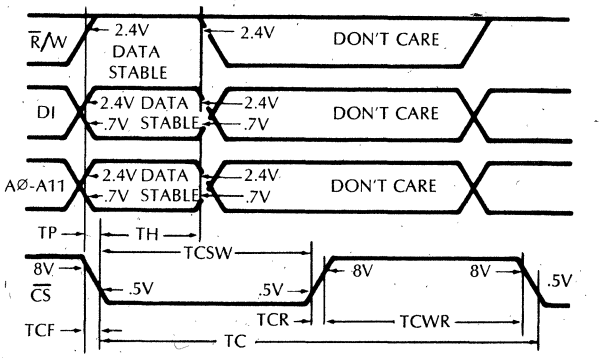
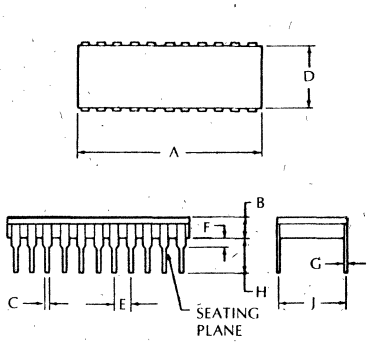


Figure 2 — Write Cycle



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	27.1	27.8	1.065	1.095
B	—	3.56	—	0.140
C	0.38	0.53	0.015	0.023
D	8.64	10.8	0.340	0.425
E	2.29	2.79	0.090	0.110
F	0.51	1.27	0.020	0.050
G	0.20	0.30	0.008	0.012
H	3.42	3.93	0.135	0.155
J	10.2 REF		0.4 REF	

CERAMIC PACKAGE DIMENSIONS

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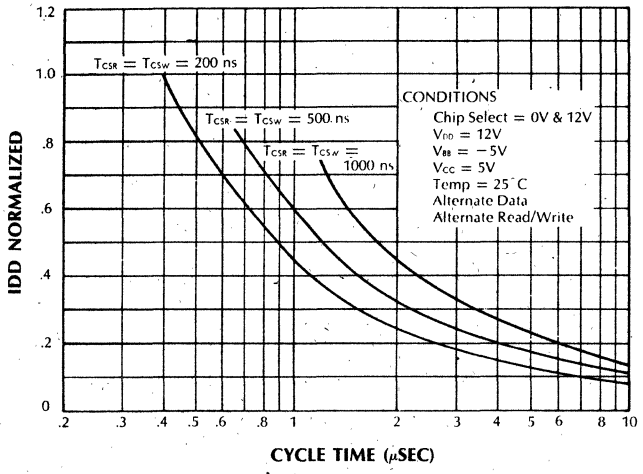


Figure 3. OPERATING I_{DD} AS A FUNCTION OF CYCLE TIME

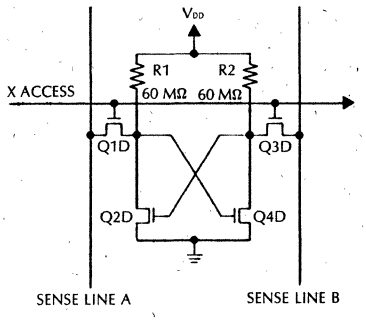


Figure 4. MEMORY CELL

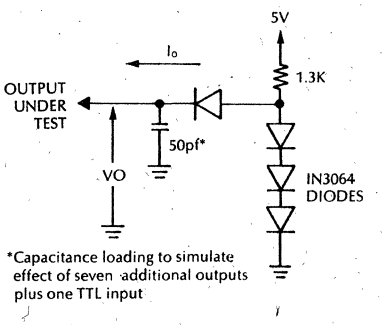


Figure 5. OUTPUT TEST LOAD

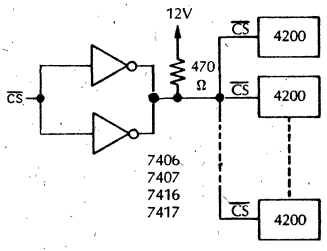


Figure 6. TYPICAL CHIP SELECT DRIVER

DEVICE OPERATION

Basic Operation

The 4096 static bits of memory organized in an array of 64 rows by 64 columns. The memory cells are loaded or interrogated by simultaneously decoding the X address A_0 through A_5 for the rows (see Block Diagram) and the Y address A_6 through A_{11} for the columns. Each column contains a presense amplifier, the outputs of which are "OR-ed" and connected to the output TTL buffer. Each bit or memory cell is a standard flip flop consisting of R_1, R_2, Q2D, and Q4D with two access devices Q1D and Q3D (See Figure 4). The load resistors R_1 and R_2 are 60 megohms typical and connect to the V_{DD} supply. Q1D and Q3D are used to connect the cell to the sense lines whenever the X access line is high. In the read mode the cells pulls one of the sense lines low from its normally high state. The selected presense circuit detects the differential voltage on the sense lines and amplifies it. In the write mode one sense line is forced low by the presense circuit and the selected cell assumes the state of the sense lines.

Chip Select

The Chip Select controls the operation of the memory. When the Chip Select input is high the input address buffers, decoders, sensing circuits and output stages are held in the "off" state and power is supplied only to the memory elements. When the Chip Select input is pulled low, the memory is enabled. The Chip Select negative going edge clocks the TTL logic level addresses R/W, and data input into "D" type flip flops, and enables the output stage.

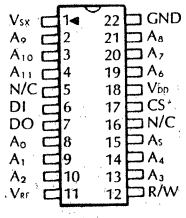
Data Output

While Chip Select is high, the output is high impedance to allow "wire-or" connections. When Chip Select goes low, the output data will be presented within the specified access time, and will remain until Chip Select goes high again. The output data signal is specified to drive any TTL series with good noise immunity at a fan-out of 1. Output data is inverted with respect to the input data.

22 PIN DUAL IN-LINE

PIN	SYMBOL	FUNCTION
1	V_{SX}	Supply Voltage (—5V)
2	A_9	Address Input
3	A_{10}	Address Input
4	A_{11}	Address Input
5	N/C	
6	D_1	Data In
7	$\overline{D_0}$	Data Out
8	A_0	Address Input
9	A_1	Address Input
10	A_2	Address Input
11	V_{RF}	Supply Voltage (5V)
12	R/W	Read/Write Input
13	A_3	Address Input
14	A_4	Address Input
15	A_5	Address Input
16	N/C	
17	$\overline{CS}$	Chip Select
18	V_{DD}	Supply Voltage (12V)
19	A_6	Address Input
20	A_7	Address Input
21	A_8	Address Input
22	GND	Ground

TOP VIEW



PIN ASSIGNMENT

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Battery Operation/Power Failure Data Retention

The memory cells (because they are cross coupled high impedance static cells) will retain data down to V_{DD} = 4V.

Input Circuits — $\overline{R}$/W Select, Data In and Address Input

The input signal is latched by Chip Select and can change after the specified hold time. The inputs can be driven from standard TTL open collector outputs with pull-up resistors. The input does not put any DC loading on the TTL driver.

$\overline{Read}$/Write Mode Select

To WRITE, the $\overline{R}$/W Input should be high prior to Chip Select. To READ, the $\overline{R}$/W Input should be low prior to Chip Select. When Chip Select goes low, $\overline{R}$/W is latched into a register.

Data In

During a WRITE cycle the Data In (either high or low) should be stable prior to Chip Select. When Chip Select goes low, Data In is latched into a register.

Address

Addresses should be stable prior to Chip Select. When Chip Select goes low all addresses are latched into an Address Register.

WARNING:

MOS CIRCUITS ARE SUBJECT TO DAMAGE FROM STATIC DISCHARGE

Internal static discharge circuits are provided to minimize part damage due to environmental static electrical charge build-ups. Industry established recommendations for handling MOS circuits include:

1. Ship and store product in conductive shipping tubes or in conductive foam plastic. Never ship or store product in non-conductive plastic containers or non-conductive plastic foam material.
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3883 North 28th Avenue, Phoenix, Arizona 85017
Telephone: (602) 263-0202

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HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HM-6501

256 X 4 CMOS RAM

FEATURES

- Organized 256 x 4
- Low Power Standby - 50 nW/Bit
- Low Power Operation - 15 μW/Bit (1Mhz)
- Data Retention at 2.0 Volts, Standard
- TTL Compatible In/Out
- Three-State Output
- High Output Drive
- Latched Outputs
- Address Register on Chip
- Fast Access Time - 285 nsec
- High Noise Immunity
- Military Temperature Range
- Industrial Temperature Range
- Dual-In-Line Package
- Flat Pack
- Common Pinout

DESCRIPTION

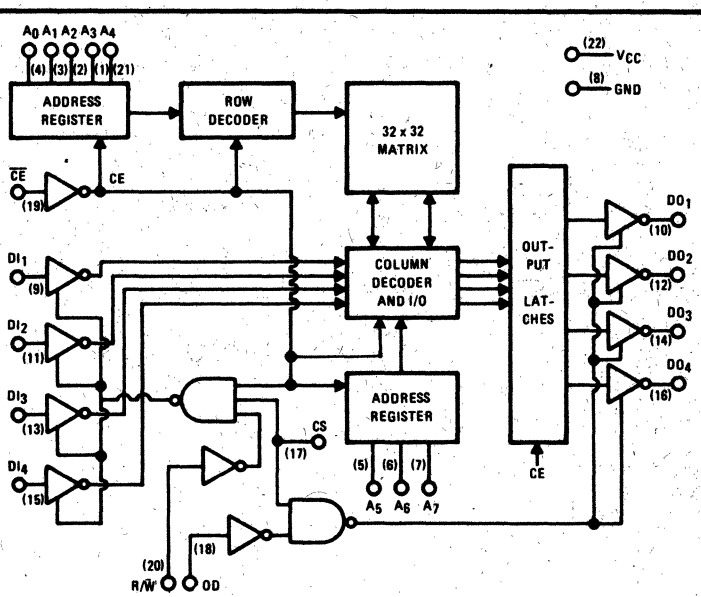
The HM-6501 is a self-aligned silicon gate CMOS 256 x 4 RAM using synchronous circuit techniques to achieve high performance with low active as well as low standby power.

The $\overline{CE}$ input is used to synchronously latch addresses into buffers and to latch the outputs; $\overline{CE}$ and CS are used to enable data inputs and Read/Write operations. Either OD or CS can be used to insure that the outputs are in a high impedance state for unselected devices, which allows convenient memory array expansion.

Split inputs and outputs avoid the multiplexing and demultiplexing of input/output data and permits greater flexibility in timing on data busses. However, the inputs and outputs can be tied together if OD is used. This unit can replace the Intel 5101 if Pin 19 (Intel's CS1) undergoes a high-to-low transition after each address change. The benefits of using an HM-6501 include fast access time and lower operating power consumption.

Data is retained at values of V_{CC} as low as 2.0V over temperature, which allows great flexibilty in designs for applications using battery backup for "non-volitility."

FUNCTIONAL DIAGRAM

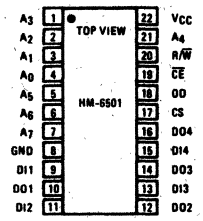


TRUTH TABLE

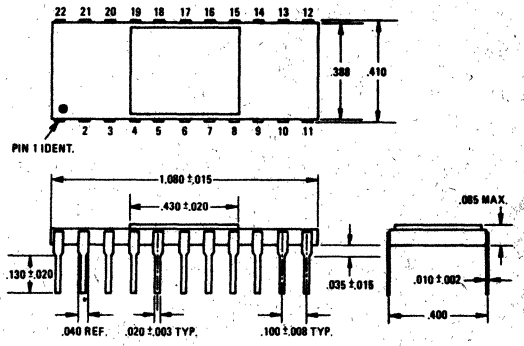
$\overline{CE}$	CS	OD	R/$\overline{W}$	DI	FUNCTION
L	H	X	L	L	WRITE 0; SEPARATE I/O
L	H	H	L	L	WRITE 0; COMMON I/O
L	H	X	L	H	WRITE 1; SEPARATE I/O
L	H	H	L	H	WRITE 1; COMMON I/O
L	H	L	H	X	READ DATA
X	L	X	X	X	CHIP DISABLED; OUTPUTS →HI Z
H	X	H	X	X	CHIP DISABLED; OUTPUTS →HI Z
H	H	L	X	X	OUTPUTS LATCHED TO LAST DATA

X = "DON'T CARE."

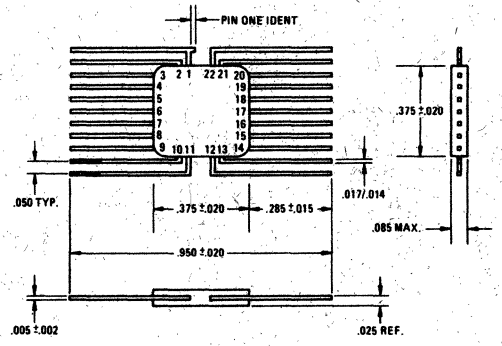
PINOUT/PACKAGES



22 LEAD D.I.P.



22 LEAD FLAT PACK



1. All dimensions in inches.
2. All dimensions ±.010 unless otherwise shown.

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HARRIS SEMICONDUCTOR
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HM-6551

256 x 4 CMOS RAM

FEATURES

- Organized 256 x 4
- Low Power Standby - 50 nW/Bit
- Low Power Operation - 15 μW/Bit (1 Mhz)
- Data Retention at 2.0 Volts, Standard
- TTL Compatible In/Out
- Three-State Output
- High Output Drive
- Latched Outputs
- Optimized for Microprocessor Use
- Address Register on Chip
- $\overline{CS_2}$ Register on Chip
- Fast Access Time - 285 nsec
- High Noise Immunity
- Military Temperature Range
- Industrial Temperature Range
- Dual-In-Line Package
- Flat Pack

TRUTH TABLE

$\overline{CE}$	$\overline{CS_1}$	$\overline{CS_2}$	R/$\overline{W}$	DI	FUNCTION
L	L	L	L	L	WRITE 0; OUTPUTS→HI-Z
L	L	L	L	H	WRITE 1; OUTPUTS→HI-Z
L	L	L	H	X	READ DATA
X	H	X	X	X	CHIP DISABLED: OUTPUTS→HI-Z
X	X	H	X	X	CHIP DISABLED; OUTPUTS→HI-Z
H	X	X	L	X	CHIP DISABLED; OUTPUTS→HI-Z
H	L	L	H	X	OUTPUTS LATCHED TO LAST DATA

X = DON'T CARE

DESCRIPTION

The HM-6551 is a self-aligned silicon gate CMOS 256 x 4 RAM using synchronous circuit techniques to achieve high performance with low active as well as low standby power.

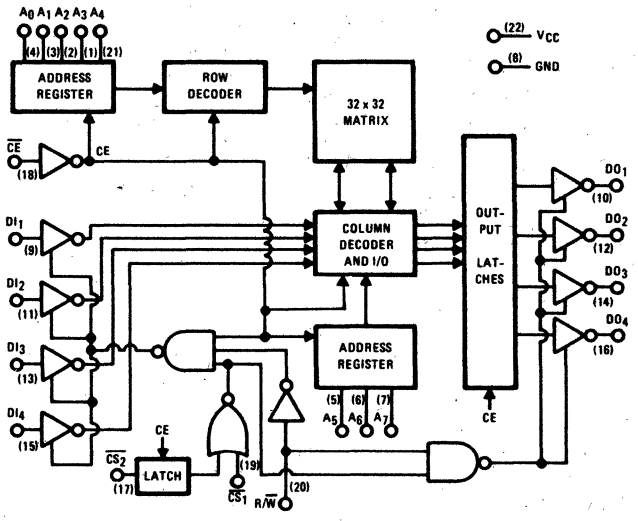
Read/Write operations are enabled by $\overline{CE}$, $\overline{CS_1}$, and $\overline{CS_2}$. The high impedance state of the data outputs is controlled by both $\overline{CS_1}$ and $\overline{CS_2}$, and the outputs are latched by $\overline{CE}$. These features permit easy memory array expansion.

$\overline{CE}$ is used to latch addresses and $\overline{CS_2}$ into the device so that these signals need only be valid for a relatively short part of the cycle. This is a convenience in many microprocessor-related and other small memory applications.

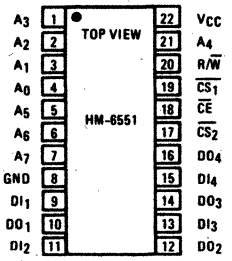
Separate data inputs and outputs avoid the multiplexing and demultiplexing of inputs/outputs and permit greater flexibility in timing on data busses. However, the inputs and outputs can be tied together because the R/$\overline{W}$ controls the input and output paths.

Data is retained at values of V_{CC} as low as 2.0V over temperature, which allows great flexibility in designs for applications using battery backup for "non-volitility."

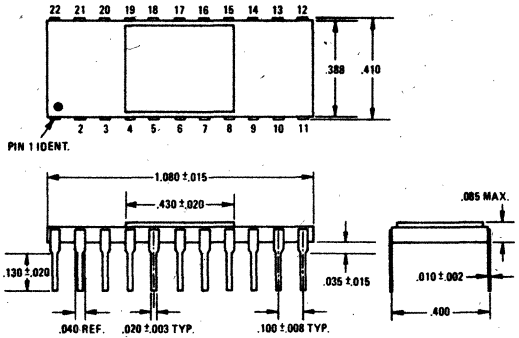
FUNCTIONAL DIAGRAM



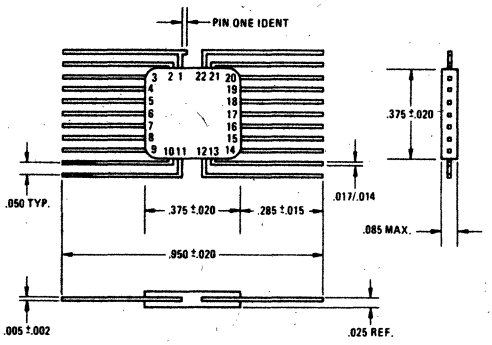
PINOUT/PACKAGES



22 LEAD D.I.P.



22 LEAD FLAT PACK



1. All dimensions in inches.
2. All dimensions ±.010 unless otherwise shown.

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HARRIS SEMICONDUCTOR
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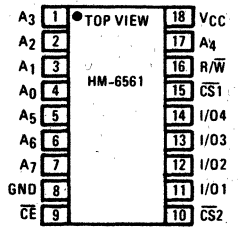
HM-6561

256 X 4 CMOS RAM

FEATURES

- Organized 256 x 4
- Low Power Standby - 50 nW/Bit
- Low Power Operation - 15μW/Bit (1 MHz)
- Data Retention at 2.0 Volts, Standard
- TTL Compatible In/Out
- Three-State Output
- High Output Drive
- Optimized for Microprocessor Use
- Common I/O
- Address Register on Chip
- Fast Access Time - 285 nsec
- High Noise Immunity
- Military Temperature Range
- Industrial Temperature Range
- Dual-In-Line Package
- Flat Pack

PINOUT



DESCRIPTION

The HM-6561 is a self-aligned silicon gate CMOS 256 x 4 RAM using synchronous techniques to achieve high performance with low active as well as low standby power.

Read/Write operations are enabled by $\overline{CE}$, $\overline{CS1}$ and $\overline{CS2}$. The high impedance state of the data outputs is controlled by both $\overline{CS1}$ and $\overline{CS2}$, and the outputs are latched by $\overline{CE}$.. These features permit easy memory array expansion. $\overline{CE}$ is used to latch addresses into the device so that addresses need only be valid for a relatively short part of the cycle.

Common data inputs and outputs make it convenient to interface to the I/O busses used in microprocessor and other small memory applications.

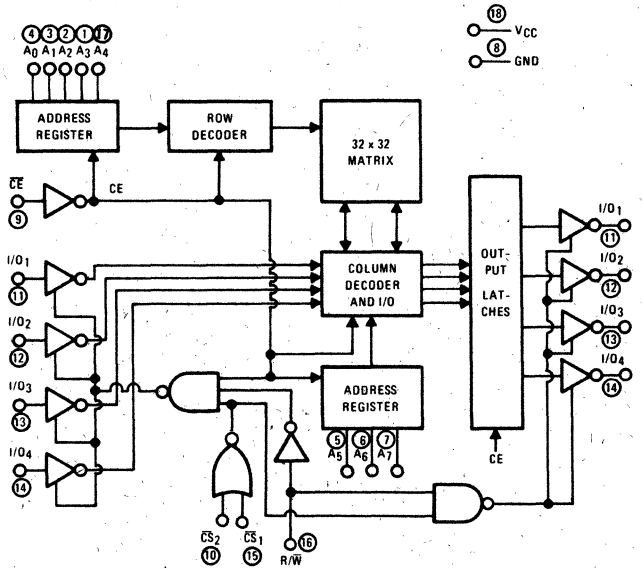
Data is retained at values of V_{CC} as low as 2.0 Volts over temperatures, which allows great flexibility in designs for applications using battery backup for "non-volitility."

TRUTH TABLE

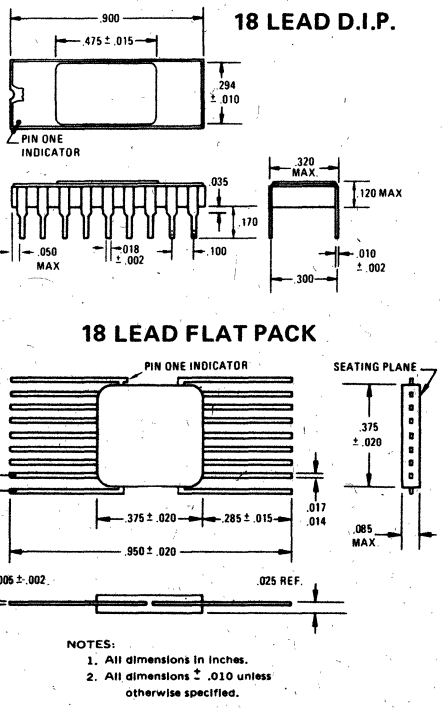
$\overline{CE}$	$\overline{CS1}$	$\overline{CS2}$	R/$\overline{W}$	I/O	FUNCTION
L	L	L	L	L	WRITE 0; I/O→HiZ
L	L	L	L	H	WRITE 1; I/O→HiZ
L	L	L	H	X	READ DATA
X	H	X	X	X	CHIP DISABLED; I/O→HiZ
X	X	H	X	X	CHIP DISABLED; I/O→HiZ
H	X	X	L	X	CHIP DISABLED; I/O→HiZ
H	L	L	H	X	OUTPUT LATCHED TO LAST DATA

X = DON'T CARE

FUNCTIONAL DIAGRAM



PACKAGING



NOTES:
1. All dimensions in inches.
2. All dimensions ± .010 unless otherwise specified.

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HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

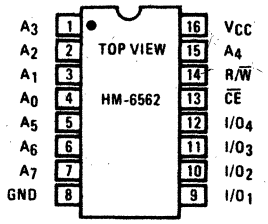
HM-6562

256 X 4 CMOS RAM

FEATURES

- Organized 256 x 4
- Low Power Standby - 50 nW/Bit
- Low Power Operation - 15μW/Bit (1MHz)
- Data Retention at 2.0 Volts Standard
- TTL Compatible In/Out
- Three-State Output
- High Output Drive
- Common Data I/O
- Minimum Package Size for High Density
- Output Disabled by $\overline{CE}$
- Fast Access Time - 285 nsec
- High Noise Immunity
- Military Temperature Range
- Industrial Temperature Range
- Dual-In-Line Package
- Flat Pack

PINOUT



DESCRIPTION

The HM-6562 is a self-aligned silicon gate CMOS 256 x 4 RAM using synchronous circuit techniques to accomplish high performance with low active as well as low standby power.

Data inputs and outputs are enabled by $\overline{CE}$, which permits convenient memory array expansion. The addresses are latched into the device by $\overline{CE}$, allowing the addresses to be valid for only a short part of the cycle. Outputs are disabled when $\overline{CE}$ is high.

Common data inputs and data outputs make it convenient to interface to the I/O busses used in microprocessor and similar applications.

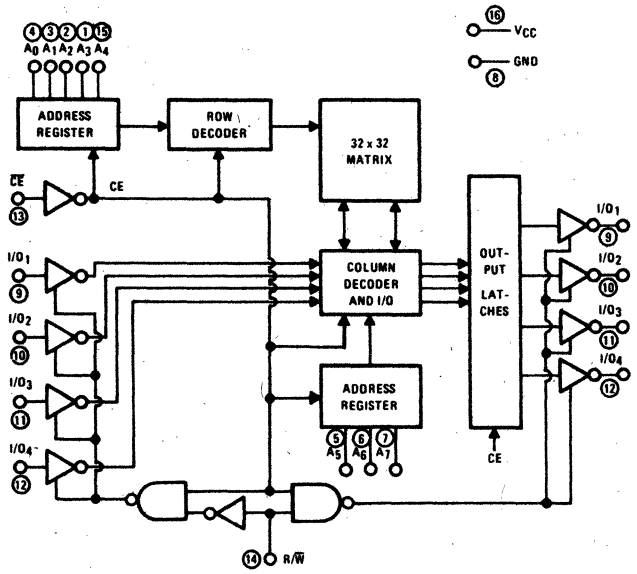
Data is retained at values of V_{CC} as low as 2.0 Volts over temperature, which allows great flexibility in designs for applications using battery backup for "non-volitility.

TRUTH TABLE

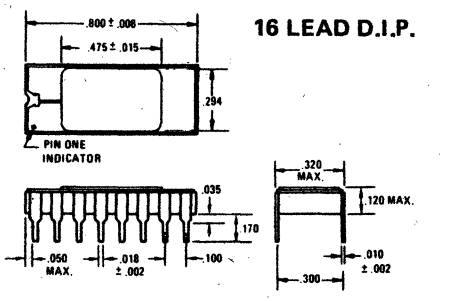
$\overline{CE}$	R/$\overline{W}$	I/O	FUNCTION
L	L	L	WRITE 0; I/O→HIZ
L	L	H	WRITE 1; I/O→HIZ
L	H	–	READ DATA
H	X	X	CHIP DISABLED: I/O→HIZ

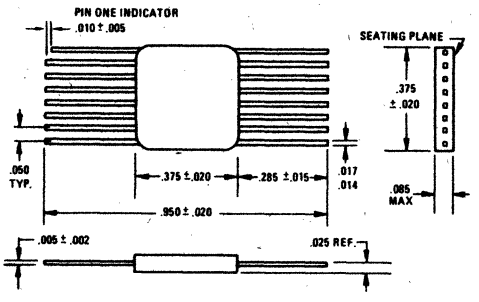
X = DON'T CARE.

FUNCTIONAL DIAGRAM



PACKAGING





NOTES:
1. All dimensions in inches.
2. All dimensions ± .010 unless otherwise specified.

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HARRIS SEMICONDUCTOR
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HM-6508/HM-6518

1024 x 1 CMOS RAM

FEATURES

- ORGANIZED 1024 x 1
- LOW POWER STANDBY – 50nW/BIT
- LOW POWER OPERATION – 15 μW/BIT (1MHz)
- DATA RETENTION AT 2.0 VOLTS
- TTL COMPATIBLE IN/OUT
- THREE-STATE OUTPUT
- HIGH OUTPUT DRIVE – 2 TTL LOADS
- ADDRESS REGISTER ON CHIP
- FAST ACCESS TIME – 290ns
- HIGH NOISE IMMUNITY
- MILITARY TEMPERATURE RANGE
- INDUSTRIAL TEMPERATURE RANGE
- DUAL IN-LINE PACKAGE
- FLAT PACK

DESCRIPTION

The Harris HM-6508 and HM-6518 RAM's use complementary MOS technology, with self-aligned silicon gates. This technology gives a very high performance memory with the least possible power consumption. The low power aspects of this device have been enhanced through the use of a synchronous circuit design which consumes no DC power when the memory is static, in either the active or standby condition. While power is normally the domain of CMOS, the input and output buffers interface efficiently with all TTL logic families, and the single 5 volt power supply assures complete system compatibility.

Three-state output buffers, and a chip-enable pin, allow both versions to be efficiently expanded in bus oriented systems. Further, on the 18 pin HM-6518, the latched output is controlled by two additional chip-select pins. This latch allows pipe-lining where speed is paramount, or the use of a common address and I/O bus where wiring density is paramount. Our memory design assures that the absolute minimum is required in support logic.

Data retention is guaranteed at 2.0V V_{CC} for all units.

TRUTH TABLE

HM-6508

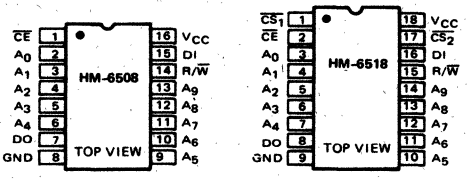
$\overline{CE}$	R/$\overline{W}$	DI	FUNCTION
L	L	L	WRITE 0; DO→HI-Z
L	L	H	WRITE 1; DO→HI-Z
L	H	–	READ DATA
H	X	X	CHIP DISABLED: DO→HI-Z

HM-6518

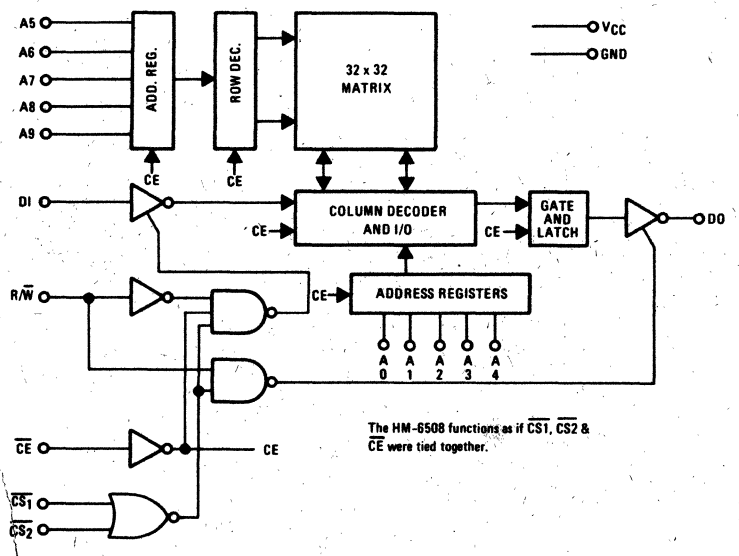
$\overline{CE}$	$\overline{CS_1}$	$\overline{CS_2}$	R/$\overline{W}$	DI	FUNCTION
L	L	L	L	L	WRITE 0; OUTPUTS→HI-Z
L	L	L	L	H	WRITE 1; OUTPUTS→HI-Z
L	L	L	H	X	READ DATA
X	H	X	X	X	CHIP DISABLED: OUTPUTS→HI-Z
X	X	H	X	X	CHIP DISABLED: OUTPUTS→HI-Z
H	X	X	L	X	CHIP DISABLED: OUTPUTS→HI-Z
H	L	L	H	X	OUTPUTS LATCHED TO LAST DATA

X = DON'T CARE

PINOUTS

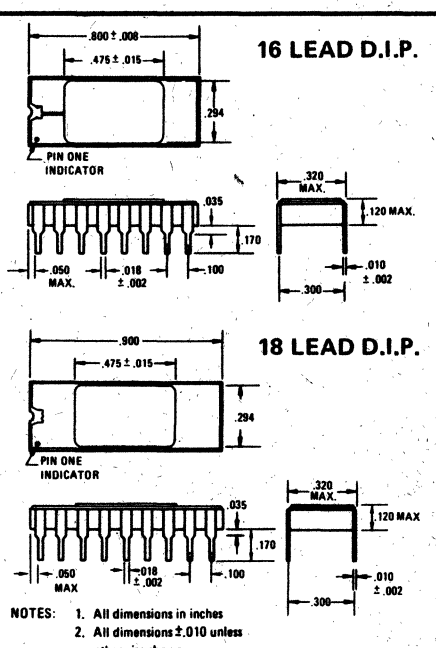


BLOCK DIAGRAM



The HM-6508 functions as if $\overline{CS1}$, $\overline{CS2}$ & $\overline{CE}$ were tied together.

PACKAGING



NOTES: 1. All dimensions in inches
2. All dimensions ±.010 unless otherwise shown

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HARRIS SEMICONDUCTOR
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PRELIMINARY

HM-6610/11

1024-BIT FIELD PROGRAMMABLE CMOS PROM

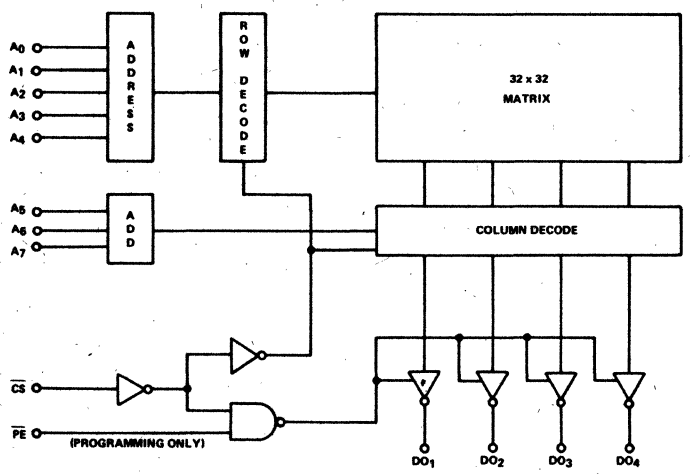
FEATURES

- Fused Link PROM
- Field-Programmable
- Organized 256 x 4
- Low Power Standby – 500μw
- Low Power Enabled – 50mw
- CMOS RAM Pinout Except for $\overline{PE}$
- TTL Compatible In/Out
- Three-State Output – 6611
- Open Drain Output – 6610
- Fully Static Operation
- On-Board Programmable
- Fast Access Time – 450nsec
- High Noise Immunity
- High Reliability
- Military Temperature Range
- Industrial Temperature Range
- Dual-In-Line Package
- High Output Drive

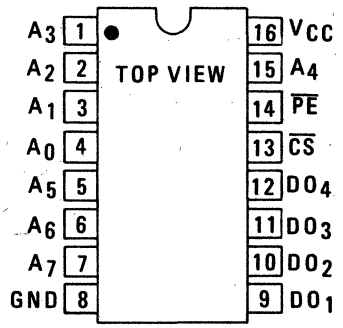
DESCRIPTION

The HM-6610 and HM-6611 are a part of a family of fusible link CMOS PROM's, which have open drain and three-state outputs respectively. Both devices are static, TTL-compatible, and have a 100μA standby current over temp. at a V_{CC} of 5 volts. Full mil. temp. range of operation is available and 10V nominal operation is available. Chip Select ($\overline{CS}$) is used to place the device in the standby state and also forces the outputs into the high-impedance state when it is high. Program Enable ($\overline{PE}$) is used only during programming, and may be left open or connected to V_{CC} in the system. Pinout is similar to bipolar PROM's and 256 x 4 to CMOS RAM's for flexibility in P.C. board layout and memory allocation by type.

FUNCTIONAL DIAGRAM

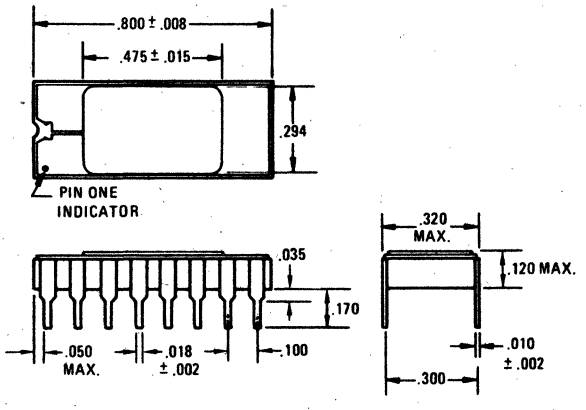


PINOUT



PACKAGING

16 LEAD D.I.P.



NOTES:

1. All dimensions in inches
2. All dimensions +.010 unless otherwise shown

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HARRIS SEMICONDUCTOR
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PRELIMINARY

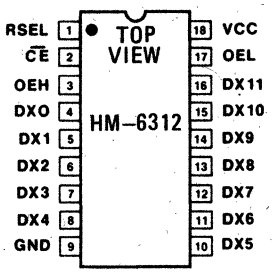
HM-6312/6312A

CMOS ROM
1024 WORD x 12 BIT

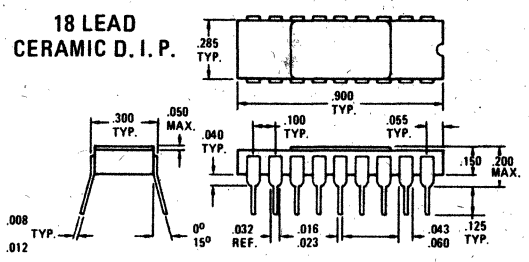
FEATURES

- HM-6100 COMPATIBLE
- LOW POWER - TYP. $< 5.0\mu W$ STANDBY
- 4 - 11 VOLT V_{CC} OPERATION
- HIGH SPEED
- STATIC OPERATION

PINOUT/PACKAGE



18 LEAD CERAMIC D.I.P.



NOTE: Board drilling dimensions will equal standard practice for .020 diameter lead.

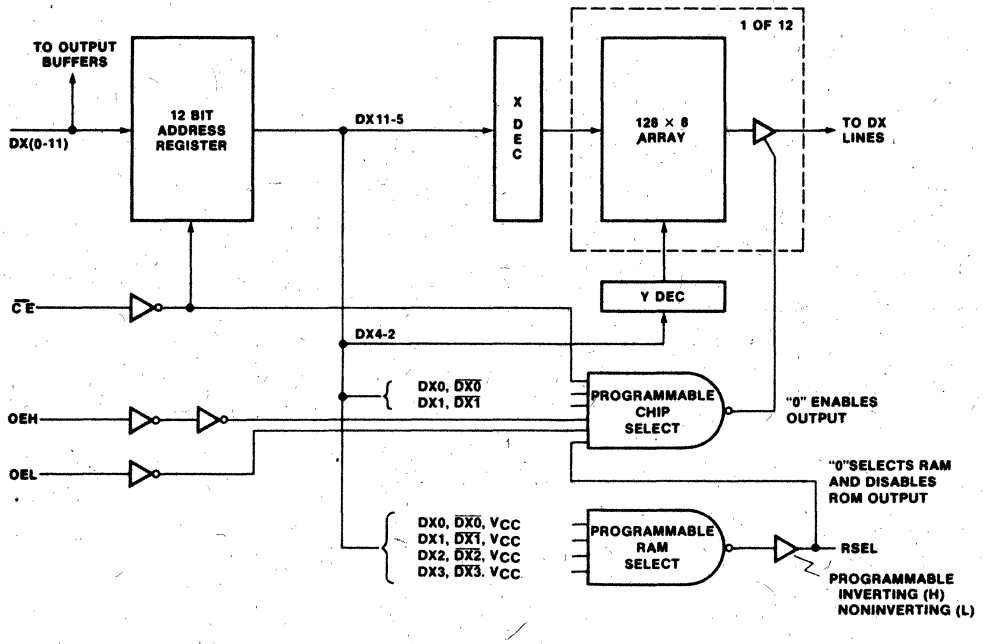
DESCRIPTION

The HM-6312 and HM-6312A are high speed, low power, silicon gate CMOS static ROM's organized 1024 words by 12 bits. In all static states these units exhibit the microwatt power requirements typical of CMOS. The basic part operates at 4 - 7 Volts with a typical 5 Volt 25°C access time of 350 ns. Higher operating voltages, 4 - 11 Volts, are available with the A version. Signal polarities and functions are specified for interfacing with the HM-6100 Microprocessor.

OPERATION

Addresses and data out are multiplexed on 12 lines, DX0 - DX11. Addresses are loaded into an on chip register by the falling edge of $\overline{CE}$. Data out, corresponding to the latched address, is enabled when $\overline{CE}$ and OEL are low and OEH is high and the decoded state of DX0 and DX1 are true. The RSEL output defines an area in the 4096 word addressing space dedicated to RAM. It can be programmed by DX0, DX1, DX2, and DX3. This output eliminates a four bit register and decoder for the high order address bits to select RAM.

FUNCTIONAL DIAGRAM



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HARRIS SEMICONDUCTOR
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HM-76XX

Bipolar Generic PROM Family

ORGANIZATIONS

PART NUMBER	*OUTPUT	TOTAL BITS	WORDS X BITS/WORD
HM-7602 HM-7603	OC TS	256	32 X 8
HM-7610 HM-7611	OC TS	1024	256 X 4
HM-7620 HM-7621	OC TS	2048	512 X 4
HM-7640 HM-7641	OC TS	4096	512 X 8
HM-7642 HM-7643 HM-7644	OC TS APU	4096	1024 X 4

*OC - Open-Collector
*TS - Three-State
*APU - Active Pull-Up

FEATURES

- Common D. C. Electrical Characteristics and Programming Procedure
- Simple, High Speed Programming Procedure (1 Second per 1024 Bits, Typical)
- Expandable - "Open-Collector" or "Three-State" Outputs and Chip Enable Inputs
- Inputs and Outputs TTL Compatible
  - ▶ Low Input Current - 400μA Logic "0", 40μA Logic "1"
  - ▶ Full Output Drive - 16mA Sink, 2mA Source
- Fast Access Time - Guaranteed for Worst Case N^2 Sequencing, Over Commercial and Military Temperature and Voltage Ranges
- Pin Compatible with Industry Standard PROM's and ROM's

DESCRIPTION

The HM-76XX Generic PROM's comprise a completely compatible family having common D.C. electrical characteristics and identical programming requirements. They are fully decoded, high speed, field programmable ROM's and are available in all commonly used organizations, with both open-collector and three-state outputs. All bits are manufactured storing a logical "1" (outputs high), and can be selectively programmed for a logical "0" (outputs low.)

The nichrome fuse technology is the same as is used in the JAN approved MIL 38510/201 PROM and in all other Harris PROM's.

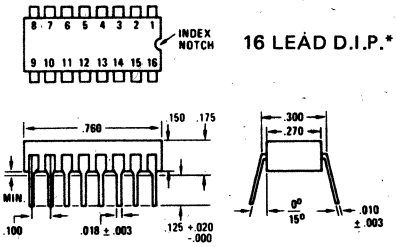
The field programmable PROM can be custom programmed to any pattern using a simple programming procedure. Schottky Bipolar circuitry provides fast access time, and features temperature and voltage compensation to minimize access time variations.

All pinouts are compatible to industry standard PROM's and ROM's.

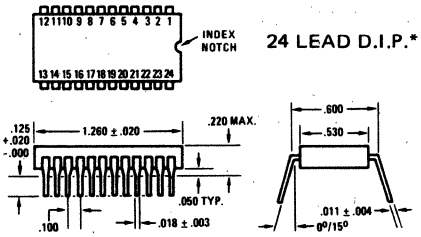
In addition to the conventional storage array, extra test rows and columns are included to assure high programmability, and guarantee parametric and A.C. performance. Fuses in these test rows and columns are blown prior to shipment.

PACKAGES

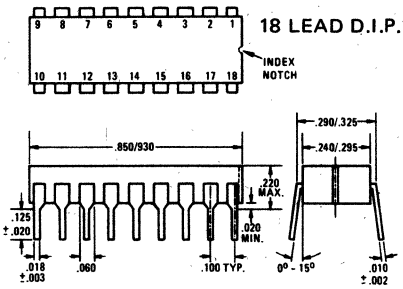
HM-7602/7603, HM-7610/7611
HM-7620/7621



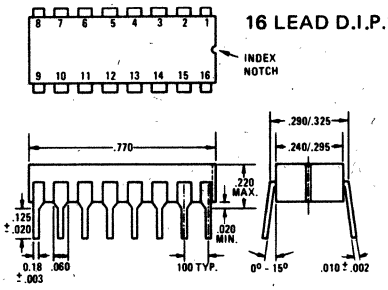
HM-7640/7641



HM-7642/7643



HM-7644



1. ALL DIMENSIONS IN INCHES.
2. ALL DIMENSIONS ±.010 UNLESS OTHERWISE SHOWN.

*Also Available in Flatpacks

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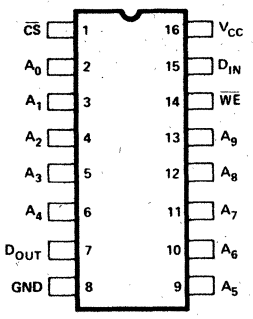
intel Silicon Gate MOS 2115, 2125

HIGH SPEED STATIC 1024 BIT RAM

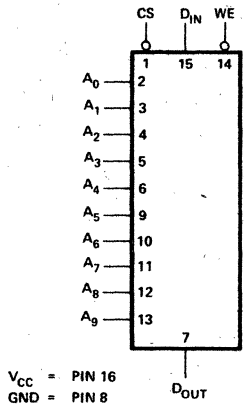
- **Access Time (2115-2/2125-2): 60ns Typical**
- **Fully Pin Compatible to 93415 (2115) and 93425 (2125)**
- **Low Operating Power Dissipation: Typical 0.2mW/bit (2115L, 2125L)**
- **Single +5V Supply**
- **Uncommitted Collector (2115) and Three-State (2125) Output**

The Intel® 2115 and 2125 family are fully static read/write random access memories organized as 1024 words by 1 bit. These RAMs are designed for buffer control storage and high performance main memory applications. They are compatible with TTL logic families in all respects: inputs, output, and a single +5V supply. Both uncommitted collector and three state output are available.

PIN CONFIGURATION



LOGIC SYMBOL



2115, 2125 FAMILY

	2115, 2125	2115-2 2125-2	2115L, 2125L
Typ. T_{AA} (ns)	70	60	75
Typ. I_{CC} (mA)	75	100	50

D.C. Characteristics [1] V_{CC} = 5V ±5%, T_A = 0°C to 75°C

Symbol	Test	Min.	Typ.	Max.	Unit	Conditions
V_{OL1}	2115, 2115L Output Low Voltage			0.45	V	I_{OL} = 12mA
V_{OL2}	2115-2, 2125-2 Output Low Voltage			0.45	V	I_{OL} = 16mA
V_{OL3}	2125, 2125L Output Low Voltage			0.45	V	I_{OL} = 7mA
V_{IH}	Input High Voltage	2.1			V	
V_{IL}	Input Low Voltage			0.8	V	
I_{IL}	Input Low Current		-1	-40	μA	V_{CC}=Max., V_{IN}=0.4V
I_{IH}	Input High Current		1	40	μA	V_{CC}=Max., V_{IN}=4.5V
I_{CEX}	2115 Family Output Leakage Current		10	100	μA	V_{CC}=Max., V_{OUT}=4.5V
$\|I_{OFF}\|$	2125 Family Output Current (High Z)		10	50	μA	V_{CC}=Max., V_{OUT}=0.5V/2.4V
I_{OS}[2]	2125 Family Current Short Circuit to Ground			-100	mA	V_{CC}=4.5V
V_{OH}	2125 Family Output High Voltage	2.4			V	I_{OH}=-3.2mA
I_{CCL}	2115L, 2125L Power Supply Current		50	65	mA	All Inputs Grounded, Output Open
I_{CC1}	2115, 2125 Power Supply Current		75	100	mA	All Inputs Grounded, Output Open
I_{CC2}	2115-2, 2125-2 Power Supply Current			125	mA	All Inputs Grounded, Output Open

Notes:
1. The operating ambient temperature ranges are guaranteed with transverse air flow exceeding 400 linear feet per minute and a two minute warm-up. Typical thermal resistance values of the package at maximum temperature are:
   θ_{JA} (@ 400 f_{PM} air flow) = 45°C/W θ_{JA} (still air) = 60°C/W θ_{JC} = 25°C/W.
2. Duration of short circuit current should not exceed 1 second.

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2115 Family A.C. Characteristics[1] V_{CC} = 5V ±5%, T_A = 0°C to 75°C

READ CYCLE

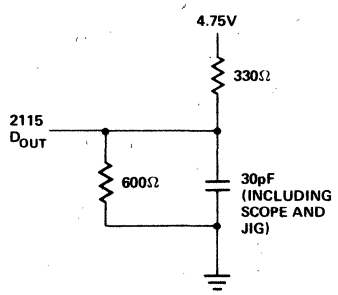
Symbol	Test	2115 Limits Min.	Typ.	Max.	2115-2 Limits Min.	Typ.	Max.	2115L Limits Min.	Typ.	Max.	Units
t_{ACS}	Chip Select Time	5		45	5		40	5		50	ns
t_{RCS}	Chip Select Recovery Time			40			40			40	ns
t_{AA}	Address Access Time		70	90		60	70		75	95	ns
t_{OH}	Previous Read Data Valid After Change of Address	10			10			10			ns

WRITE CYCLE

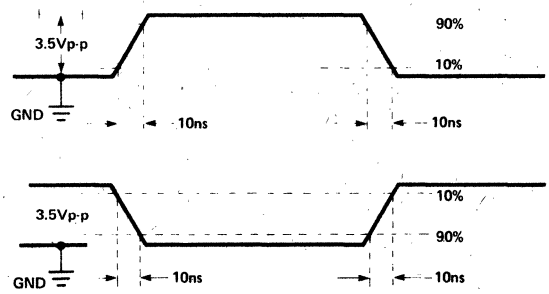
Symbol	Test	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Units
t_{WS}	Write Enable Time			40			40			40	ns
t_{WR}	Write Recovery Time	5		45	5		45	5		50	ns
t_W	Write Pulse Width	50			50			60			ns
t_{WSD}	Data Set-Up Time Prior to Write	5			5			15			ns
t_{WHD}	Data Hold Time After Write	5			5			15			ns
t_{WSA}	Address Set-Up Time	15			15			20			ns
t_{WHA}	Address Hold Time	5			5			15			ns
t_{WSCS}	Chip Select Set-Up Time	5			5			15			ns
t_{WHCS}	Chip Select Hold Time	5			5			15			ns

TEST CONDITIONS

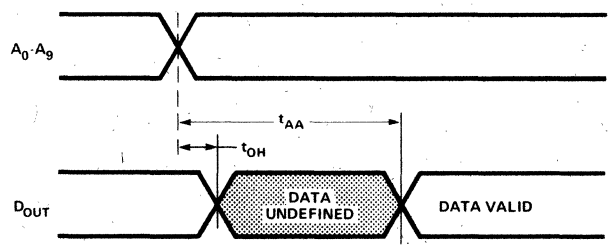
LOADING CONDITIONS



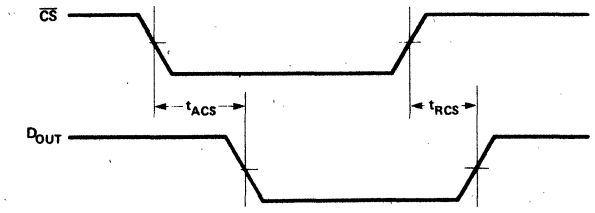
ALL INPUT PULSES



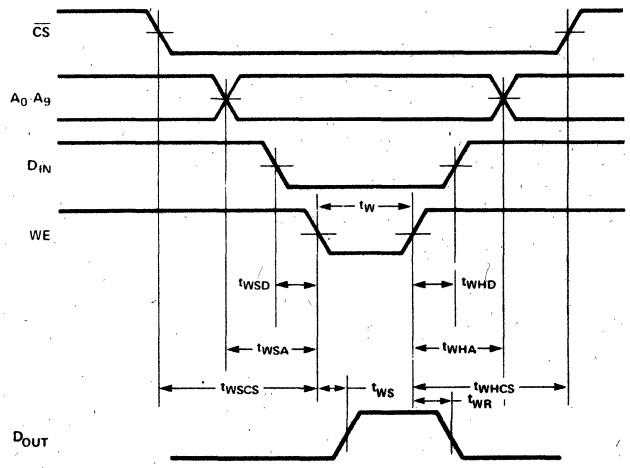
READ CYCLE



PROPAGATION DELAY FROM CHIP SELECT



WRITE CYCLE



(ALL ABOVE MEASUREMENTS REFERENCED TO 1.5V)

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2125 Family A.C. Characteristics [1] V_{CC} = 5V ±5%, T_A = 0°C to 75°C

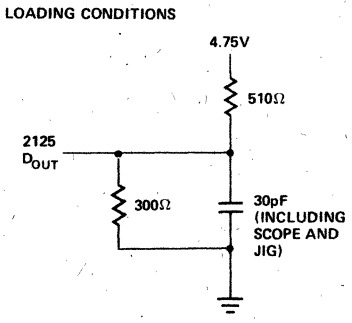
READ CYCLE

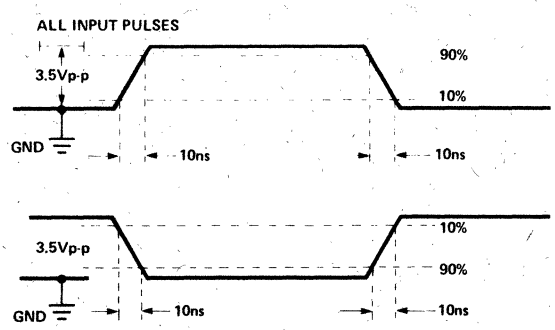
Symbol	Test	2125 Limits Min.	Typ.	Max.	2125-2 Limits Min.	Typ.	Max.	2125L Limits Min.	Typ.	Max.	Units
t_{ACS}	Chip Select Time	5		45	5		40	5		50	ns
t_{ZRCS}	Chip Select to HIGH Z			40			40			40	ns
t_{AA}	Address Access Time		70	90		60	70		75	95	ns
t_{OH}	Previous Read Data Valid After Change of Address	10			10			10			ns

WRITE CYCLE

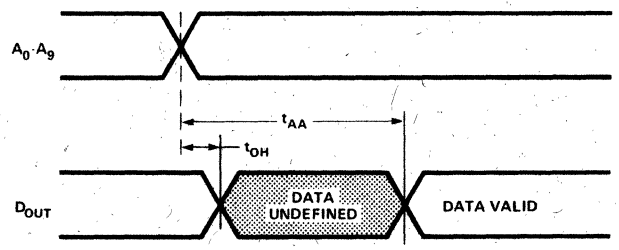
Symbol	Test	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Units
t_{ZWS}	Write Enable to HIGH Z			40			40			40	ns
t_{WR}	Write Recovery Time	5		45	5		45	5		50	ns
t_W	Write Pulse Width	50			50			60			ns
t_{WSD}	Data Set-Up Time Prior to Write	5			5			15			ns
t_{WHD}	Data Hold Time After Write	5			5			15			ns
t_{WSA}	Address Set-Up Time	15			15			20			ns
t_{WHA}	Address Hold Time	5			5			15			ns
t_{WSCS}	Chip Select Set-Up Time	5			5			15			ns
t_{WHCS}	Chip Select Hold Time	5			5			15			ns

TEST CONDITIONS

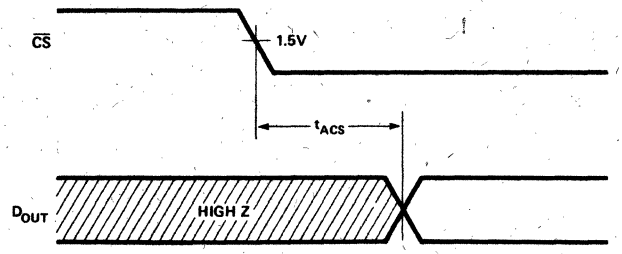




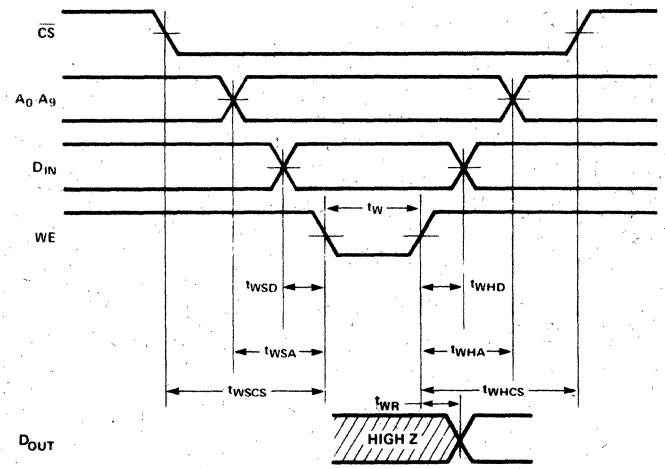
READ CYCLE



PROPAGATION DELAY FROM CHIP SELECT



WRITE CYCLE



(ALL ABOVE MEASUREMENTS REFERENCED TO 1.5V)

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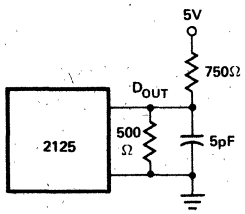
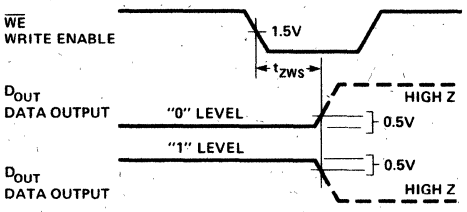
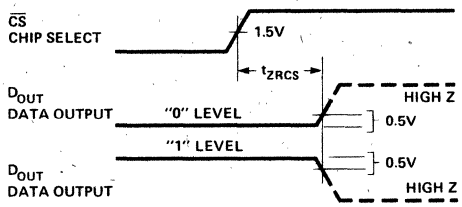
2125 FAMILY WRITE ENABLE TO HIGH Z DELAY



LOAD 1



2125 FAMILY PROPAGATION DELAY FROM CHIP SELECT TO HIGH Z



(All t_{ZXXX} parameters are measured at a delta of 0.5V from the logic level and using Load 1.)

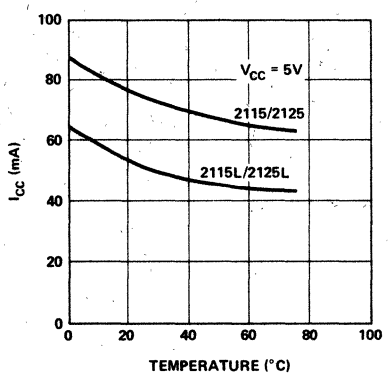
2115/2125 FAMILY CAPACITANCE* V_{CC} = 5V, f = 1 MHz, T_A = 25°C

Symbol	Test	2115 Family Limits Typ.	2115 Family Limits Max.	2125 Family Limits Typ.	2125 Family Limits Max.	Units	Test Conditions
C_I	Input Capacitance	3	5	3	5	pF	All Inputs = 0V, Output Open
C_O	Output Capacitance	5	8	5	8	pF	$\overline{CS}$=5V, All other inputs = 0V, Output Open

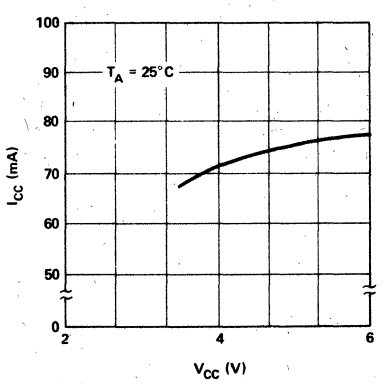
*This parameter is periodically sampled and is not 100% tested.

Typical Characteristics

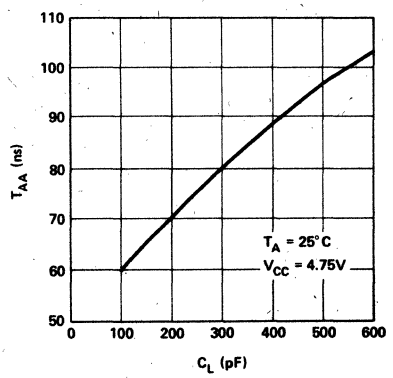
I_{CC} VS. TEMPERATURE



I_{CC} VS. V_{CC}



ACCESS TIME VS. CAPACITANCE



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2116

16,384 X 1 BIT DYNAMIC RAM

PRELIMINARY

	2116-2	2116-4	2116
Max. Access Time (ns)	250	300	350
Read, Write Cycle (ns)	375	425	500
Read-Modify-Write Cycle (ns)	525	615	700

- **Highest Density 16K RAM: Industry Standard 16 Pin Package**
- **Low Standby Power**
- **All Inputs Including Clocks TTL Compatible**
- **Standard Power Supplies +12V, +5V, -5V**
- **On-Chip Latches for Address and Data In**
- **Only 64 Refresh Cycles Required Every 2 ms**
- **Output is Three-State, TTL Compatible; Data is Latched and Valid into Next Cycle**

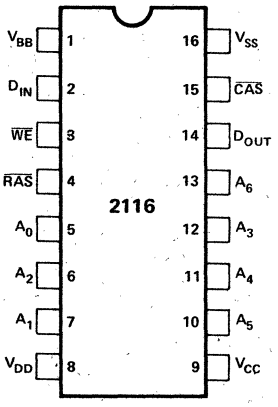
The Intel® 2116 is a 16,384 word by 1 bit MOS RAM fabricated with two layer polysilicon N-MOS technology — a production-proven process for high performance, high reliability, and high functional density. The 2116 uses a single transistor dynamic storage cell and dynamic circuitry to achieve high speed and low power dissipation.

The unique design of the 2116 allows it to be packaged in the industry standard 16 pin dual-in-line package. The 16 pin package provides the highest system bit densities and is compatible with widely available automated handling equipment. The 2116 is designed to facilitate upgrading of 2104-type 4K RAM systems to 16K capabilities.

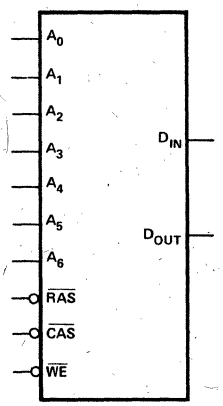
The use of the 16 pin package is made possible by multiplexing the 14 address bits (required to address 1 of 16,384 bits) into the 2116 on 7 address input pins. The two 7 bit address words are latched into the 2116 by the two TTL clocks, Row Address Strobe ($\overline{RAS}$) and Column Address Strobe ($\overline{CAS}$). Non-critical clock timing requirements allow use of the multiplexing technique while maintaining high performance.

The single transistor dynamic storage cell provides high speed along with low power dissipation. The memory cell requires refreshing for data retention. Refreshing can be accomplished every 2ms by any one of the three following methods: (1) $\overline{CAS}$ before $\overline{RAS}$ cycles on 64 addresses, A_0-A_5, (2) $\overline{RAS}$ only cycles on 128 addresses, A_0-A_6, or (3) normal read or write cycles on 128 addresses, A_0-A_6. A write cycle will refresh stored data on all bits of the selected row except the bit which is addressed. The output is brought to a high impedance state by a $\overline{CAS}$ only cycle or by a $\overline{CAS}$ before $\overline{RAS}$ refresh cycle.

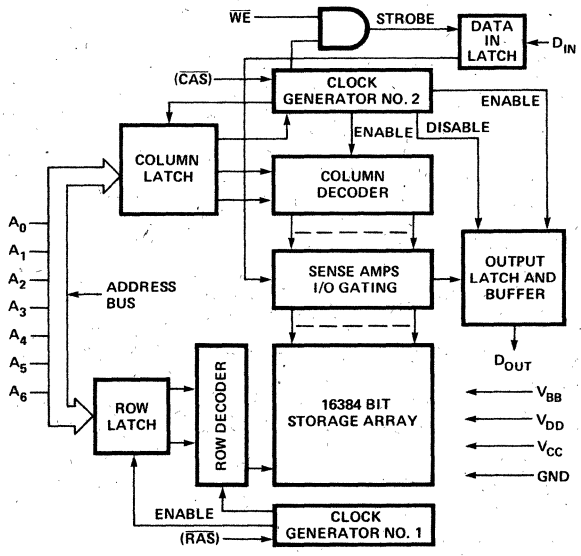
PIN CONFIGURATION



LOGIC SYMBOL



BLOCK DIAGRAM



PIN NAMES

A_0 - A_6	ADDRESS INPUTS	$\overline{WE}$	WRITE ENABLE
$\overline{CAS}$	COLUMN ADDRESS STROBE	V_{BB}	POWER (-5V)
D_{IN}	DATA IN	V_{CC}	POWER (+5V)
D_{OUT}	DATA OUT	V_{DD}	POWER (+12V)
$\overline{RAS}$	ROW ADDRESS STROBE	V_{SS}	GROUND

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PRELIMINARY
Notice: This is not a final specification. Some parametric limits are subject to change.

Absolute Maximum Ratings*

Ambient Temperature Under Bias . . . . . -10°C to +80°C
Storage Temperature . . . . . -65°C to +150°C
Voltage on any Pin Relative to V_{BB}
(V_{SS} - V_{BB} ⩾ 4.5V) . . . . . -0.3V to +20V
Power Dissipation 1.25W

*COMMENT:
Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

D.C. and Operating Characteristics [1],[2]

T_A = 0°C to 70°C, V_{DD} = +12V ±5%, V_{CC} = +5V ±10%, V_{BB} = -5V ±10%, V_{SS} = 0V, unless otherwise noted.

Symbol	Parameter	Limits			Unit	Conditions
		Min.	Typ.[3]	Max.		
I_{LI}	Input Load Current (any input)			10	μA	V_{IN} = $V_{IL\,MIN}$ to $V_{IH\,MAX}$
$\|I_{LO}\|$	Output Leakage Current for high impedance state			100	μA	Chip deselected: $\overline{RAS}$ and $\overline{CAS}$ at V_{IH} V_{OUT} = 0 to 5.5V
I_{DD1}[4]	V_{DD} Supply Current		1.4	2	mA	$\overline{CAS}$ and $\overline{RAS}$ at V_{IH}. Chip deselected prior to measurement. See Note 5.
I_{BB1}	V_{BB} Supply Current		1	90	μA	
I_{DD2}[4]	Operating V_{DD} Current		37	60	mA	t_{CYC}=500ns, t_{RP}=150ns, T_A=25°C. Device selected. See Note 6.
I_{BB2}	Operating V_{BB} Current		100	400	μA	
I_{CC1}[7]	V_{CC} Supply Current when deselected			100	μA	
V_{IL}	Input Low Voltage (any input)	-1.0		0.8	V	
V_{IH}	Input High Voltage ($\overline{CAS}$, $\overline{RAS}$, $\overline{WE}$)	2.7		V_{CC}+1	V	
	(Addresses, D_{IN})	2.4				
V_{OL}	Output Low Voltage	0.0		0.4	V	I_{OL}=4.1mA (Read Cycle Only)
V_{OH}	Output High Voltage	2.4		V_{CC}	V	I_{OH}=-5mA (Read Cycle Only)

Capacitance [8] T_A = 25°C, V_{DD}=12V ±5%, V_{CC}=5V ±10%, V_{BB}=-5V ±10%, V_{SS}=0V, unless otherwise noted.

Symbol	Test	Typ.	Max.	Unit	Conditions
C_{AD},C_{WE}	Address, Data In & $\overline{WE}$ Capacitance	4	7	pF	V_{IN} = V_{SS}
C_{RAS}	$\overline{RAS}$ Capacitance	3	7	pF	V_{IN} = V_{SS}
C_{CAS}	$\overline{CAS}$ Capacitance	6	10	pF	V_{IN} = V_{SS}
C_{OUT}	Data Output Capacitance	3	7	pF	V_{OUT} = OV

Notes:
1. All voltages referenced to V_{SS}. No power supply sequencing is required but V_{DD}, V_{CC}, and V_{SS} should never be 0.3V or more negative than V_{BB}.
2. To avoid self-clocking, $\overline{RAS}$ should not be allowed to float.
3. Typical values are for T_A = 25°C and nominal power supply voltages.
4. The I_{DD} current flows to V_{SS}.
5. The chip is deselected, i.e., output is brought to high impedance state, by $\overline{CAS}$ only cycle or by $\overline{CAS}$ before $\overline{RAS}$ refresh cycle. The current flowing in a selected, i.e., output on, chip with $\overline{RAS}$ and $\overline{CAS}$ at V_{IH} is approximately three times I_{DD1}.
6. See Page 3 for typical I_{DD} characteristics under other conditions.
7. When chip is selected V_{CC} supply current is dependent on output loading; V_{CC} is connected to output buffer only.
8. Capacitance measured with Boonton Meter.

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Typical Characteristics

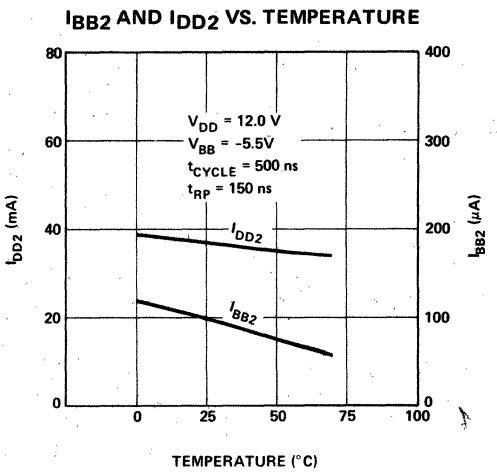


Figure 1.

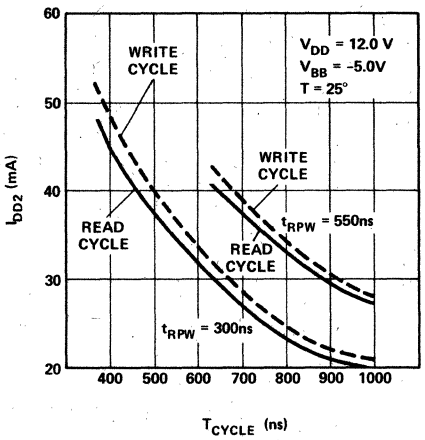


Figure 2.

Standby Power Calculations:

$$P_{REF} = P_{OP}\left(N\frac{t_{CYC}}{t_{REF}}\right) + P_{SB}\left(1 - N\frac{t_{CYC}}{t_{REF}}\right)$$ where

P_{OP} = Power dissipation — continuous operation = $V_{DD} \times I_{DD2}$.

N = Number of refresh cycles (64 or 128)

t_{CYC} = Cycle time for a refresh cycle.

t_{REF} = Time between refreshes

P_{SB} = Standby power dissipation = $V_{DD} \times I_{DD1} + |V_{BB}| \times I_{BB}$

Note that I_{DD2} depends upon refresh as follows:

1. For 128 cycle ($\overline{RAS}$ before $\overline{CAS}$) use I_{DD2} from Figures 1 and 2.
2. For 64 cycle ($\overline{CAS}$ before $\overline{RAS}$) multiply I_{DD2} determined in (1) by 0.96.
3. For 128 cycle ($\overline{RAS}$ only) multiply I_{DD2} determined in (1) by 0.78.

Examples of typical calculations for V_{BB} = -5.0V, V_{DD} = 12.0V, T_A = 25°C, t_{CYC} = 0.5 μs, t_{RPW} = 0.35 μs, t_{REF} = 2000 μs:

1. 128 cycle ($\overline{RAS}$ before $\overline{CAS}$): P_{OP} = 12.0V x 37 mA = 444 mW

   $$P_{REF} = 444\left(128\frac{0.5}{2000}\right) + (12x1.4+5x0.001)\left(1-128\frac{0.5}{2000}\right)$$

   P_{REF} = 30.5 mW.

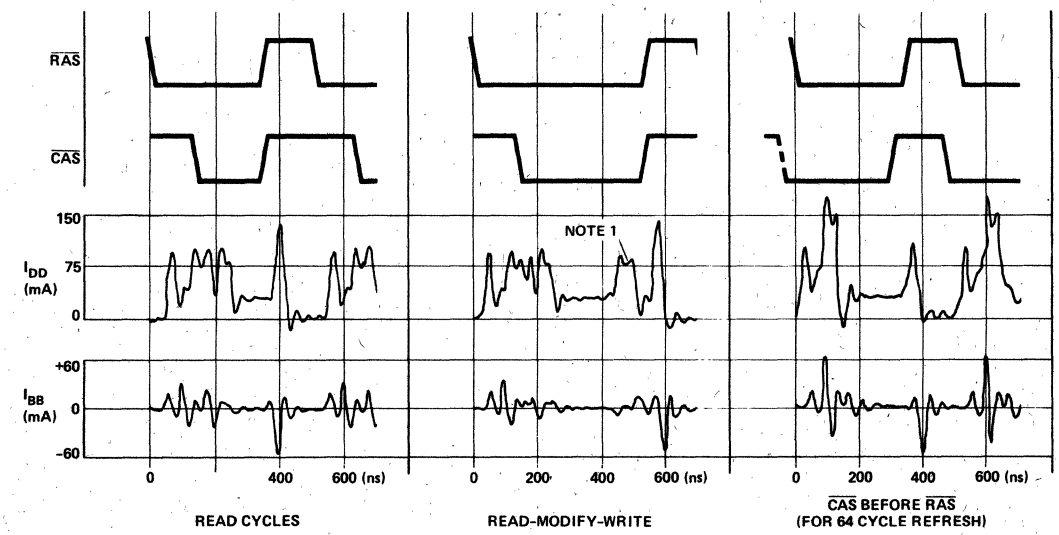
2. 64 cycle ($\overline{CAS}$ before $\overline{RAS}$): P_{OP} = 12.0V x 37 x 0.96 mA = 426 mW.

   $$P_{REF} = 426\left(64\frac{0.5}{2000}\right) + (12x1.4+5x0.001)\left(1-64\frac{0.5}{2000}\right) =$$

   P_{REF} = 23.4 mW.

3. 128 cycle ($\overline{RAS}$ only): P_{OP} = 12.0V x 37 (0.78) mA = 346 mW

   P_{REF} = 27.3 mW.



Note 1: Increase in current due to $\overline{WE}$ going low. Width of this current pulse is independent of $\overline{WE}$ pulse width.

Figure 3. Supply Current Waveforms.

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PRELIMINARY

A.C. Characteristics[1]

T_A=0°C to 70°C, V_{DD}=12V ±5%, V_{CC}=5V ±10%, V_{BB}=-5V ±10%, V_{SS}=0V, unless otherwise noted.

READ, WRITE, READ MODIFY WRITE AND REFRESH CYCLES

Symbol	Parameter	2116-2 Min.	2116-2 Max.	2116-4 Min.	2116-4 Max.	2116 Min.	2116 Max.	Unit
t_{REF}	Time Between Refresh		2		2		2	ms
t_{RP}	$\overline{RAS}$ Precharge Time	75		95		150		ns
t_{RCL}[2]	$\overline{RAS}$ to $\overline{CAS}$ Leading Edge Lead Time	70	2000	70	2000	110	2000	ns
t_{AS}	Address Set-Up Time	0		0		0		ns
t_{AH}	Address Hold Time	60		60		100		ns
t_{CRL}[3]	$\overline{RAS}$ to $\overline{CAS}$ Trailing Edge Lead Time	+20	+70	+20	+70	+20	+70	ns
t_{OFF}	Output Buffer Turn Off Delay	0	60	0	80	0	100	ns
t_{CAC}[4]	Access Time From $\overline{CAS}$		150		190		200	ns
t_{RAC}[4]	Access Time From $\overline{RAS}$		250		300		350	ns
t_T	Transition Time (Rise and Fall)		50		50		50	ns

READ AND REFRESH CYCLES

Symbol	Parameter	2116-2 Min.	2116-2 Max.	2116-4 Min.	2116-4 Max.	2116 Min.	2116 Max.	Unit
t_{CYC}[5]	Random Read Cycle Time	375		425		500		ns
t_{CPW}	$\overline{CAS}$ Pulse Width	200		220		200		ns
t_{RPW}	$\overline{RAS}$ Pulse Width	300		330		350		ns
t_{RSH}	$\overline{RAS}$ Hold Time	200		220		200		ns
t_{CSH}	$\overline{CAS}$ Hold Time	300		330		350		ns
t_{RCH}	Read Command Hold Time	80		80		80		ns
t_{RCS}	Read Command Set-Up Time	0		0		0		ns

WRITE CYCLE

Symbol	Parameter	2116-2 Min.	2116-2 Max.	2116-4 Min.	2116-4 Max.	2116 Min.	2116 Max.	Unit
t_{CYC}[5]	Random Write Cycle Time	375		425		500		ns
t_{CPW}	$\overline{CAS}$ Pulse Width	200		220		200		ns
t_{RPW}	$\overline{RAS}$ Pulse Width	300		330		350		ns
t_{RSH}	$\overline{RAS}$ Hold Time	200		220		200		ns
t_{CSH}	$\overline{CAS}$ Hold Time	300		330		350		ns
t_{CWL}	Write Command to $\overline{CAS}$ Lead Time	200		220		200		ns
t_{WCH}	Write Command Hold Time	100		100		100		ns
t_{WP}	Write Command Pulse Width	100		100		100		ns
t_{DS}[6]	Data In Set-Up Time	0		0		0		ns
t_{DH}[6]	Data In Hold Time	125		125		125		ns
t_{RWL}	Write Command to $\overline{RAS}$ Lead Time	200		220		200		ns

Notes:
1. All voltages referenced to V_{SS}.
2. $\overline{CAS}$ must remain at V_{IH} a minimum of t_{RCLMIN} after $\overline{RAS}$ switches to V_{IL}. To achieve the minimum guaranteed access time (t_{RAC}), $\overline{CAS}$ must switch to V_{IL} at or before $t_{RCL} = (t_{RAC} - t_{CAC})$.
3. t_{CRL} is measured from $\overline{RAS}$ to $\overline{CAS}$. t_{CRL} is not applicable in $\overline{CAS}$ before $\overline{RAS}$ refresh cycles.
4. Load = 1 TTL and 50pF.
5. The minimum cycle timing does not allow for t_T or skews.
6. Referenced to $\overline{CAS}$ or $\overline{WE}$, whichever occurs last.

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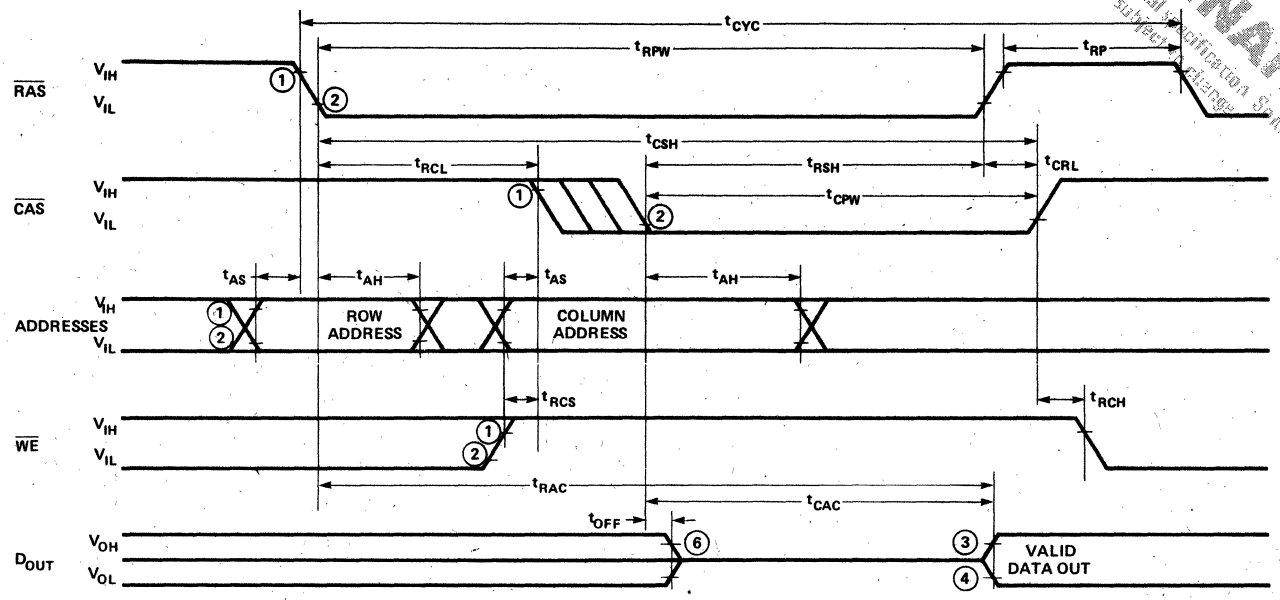
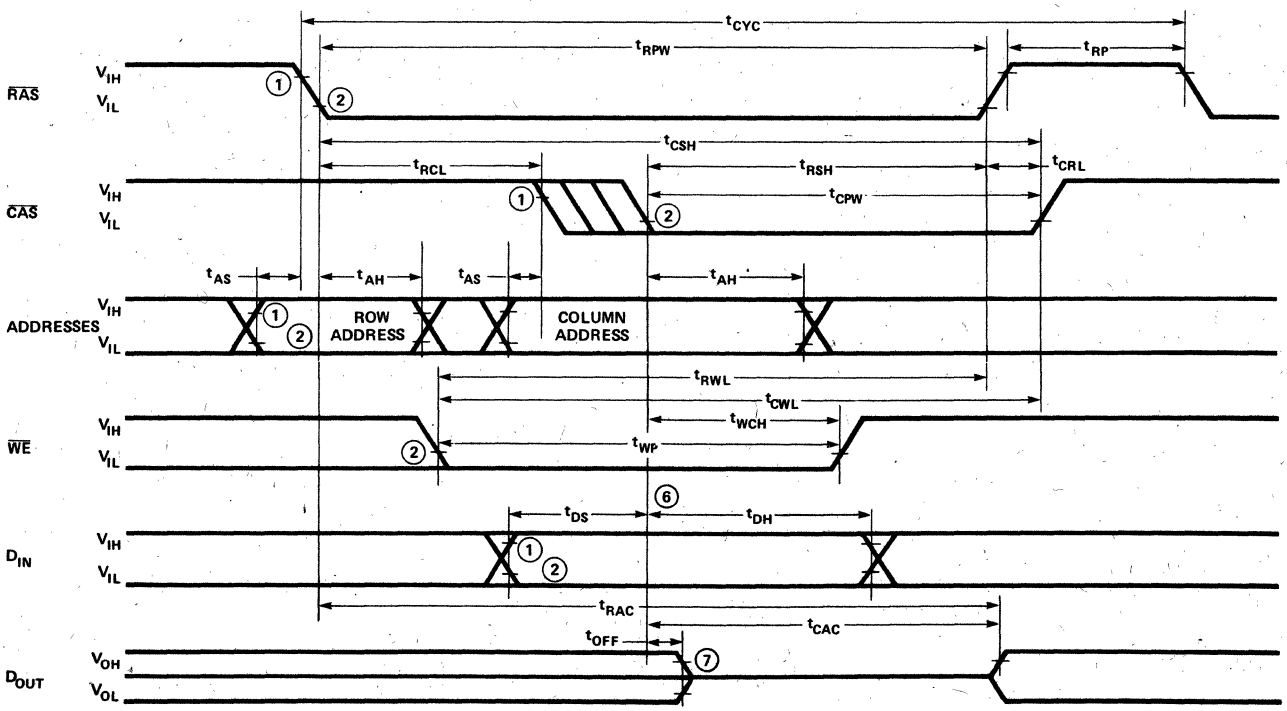
Waveforms

READ CYCLE



WRITE CYCLE



Notes: **1,2.** V_{IHMIN} and V_{ILMAX} are reference levels for measuring timing of input signals.
3,4. V_{OHMIN} and V_{OLMAX} are reference levels for measuring timing of D_{OUT}.
5. D_{OUT} follows D_{IN} when writing.
6. Referenced to $\overline{CAS}$ or $\overline{WE}$, whichever occurs last.
7. t_{OFF} is measured to $I_{OUT} \leq |I_{LO}|$.

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PRELIMINARY

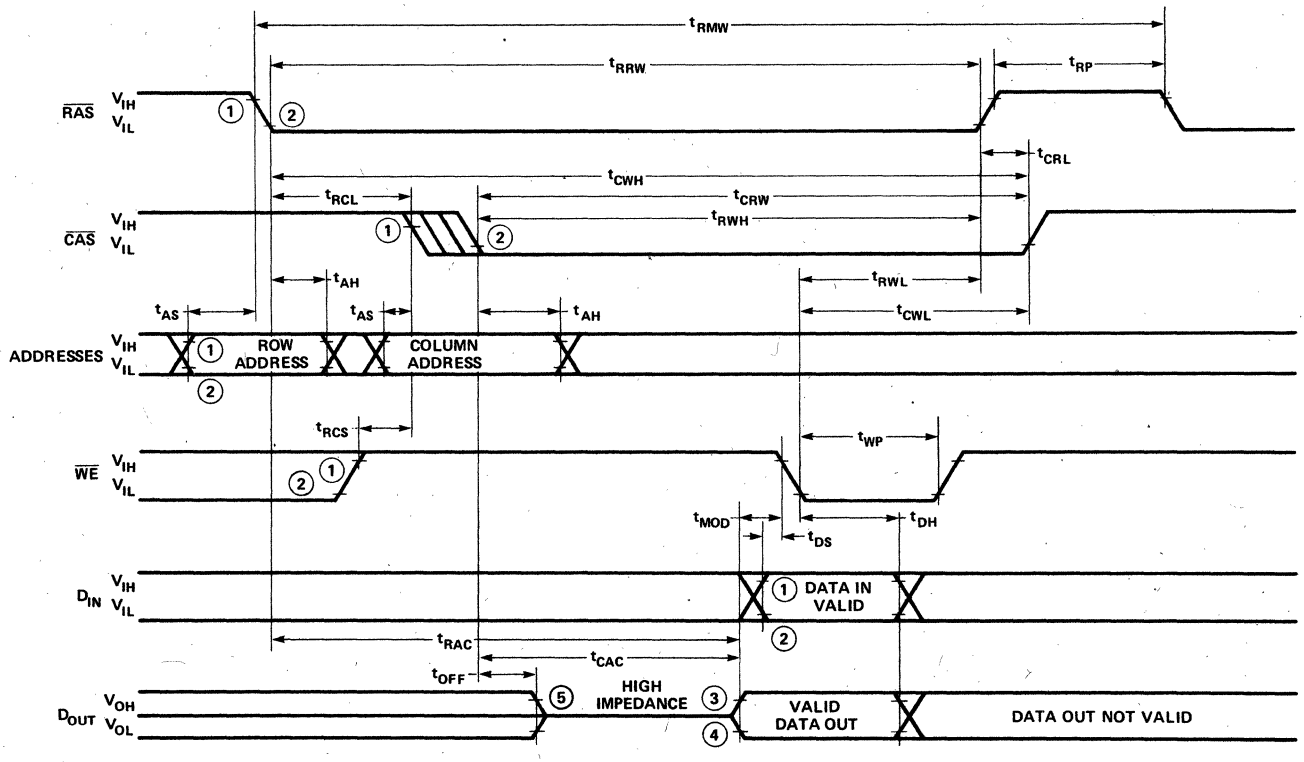
A.C. Characteristics T_A=0°C to 70°C, V_{DD}=12V ±5%, V_{CC}=5V ±10%, V_{BB}=-5V ±10%, V_{SS}=0V, unless otherwise noted.

READ MODIFY WRITE CYCLE

Symbol	Parameter	2116-2 Min.	2116-2 Max.	2116-4 Min.	2116-4 Max.	2116 Min.	2116 Max.	Unit
t_{RMW}	Read Modify Write Cycle Time	525		615		700		ns
t_{CRW}	RMW Cycle $\overline{CAS}$ Width	340		390		400		ns
t_{RRW}	RMW Cycle $\overline{RAS}$ Width	450		520		550		ns
t_{RWH}	RMW Cycle $\overline{RAS}$ Hold Time	340		390		400		ns
t_{CWH}	RMW Cycle $\overline{CAS}$ Hold Time	450		520		550		ns
t_{CWL}	Write Command to $\overline{CAS}$ Lead Time	200		220		200		ns
t_{WP}	Write Command Pulse Width	100		100		100		ns
t_{RCS}	Read Command Set-Up Time	0		0		0		ns
t_{MOD}	Modify Time	0		0		0		ns
t_{DS}	Data In Set-Up Time	0		0		0		ns
t_{DH}	Data In Hold Time	125		125		125		ns
t_{RWL}	Write Command to $\overline{RAS}$ Lead Time	200		220		200		ns

Waveforms

READ MODIFY WRITE CYCLE



Notes: 1,2. V_{IHMIN} and V_{ILMAX} are reference levels for measuring timing of input signals.
3,4. V_{OHMIN} and V_{OLMAX} are reference levels for measuring timing of D_{OUT}.
5. t_{OFF} is measured to $I_{OUT} \leq |I_{LO}|$.

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PRELIMINARY
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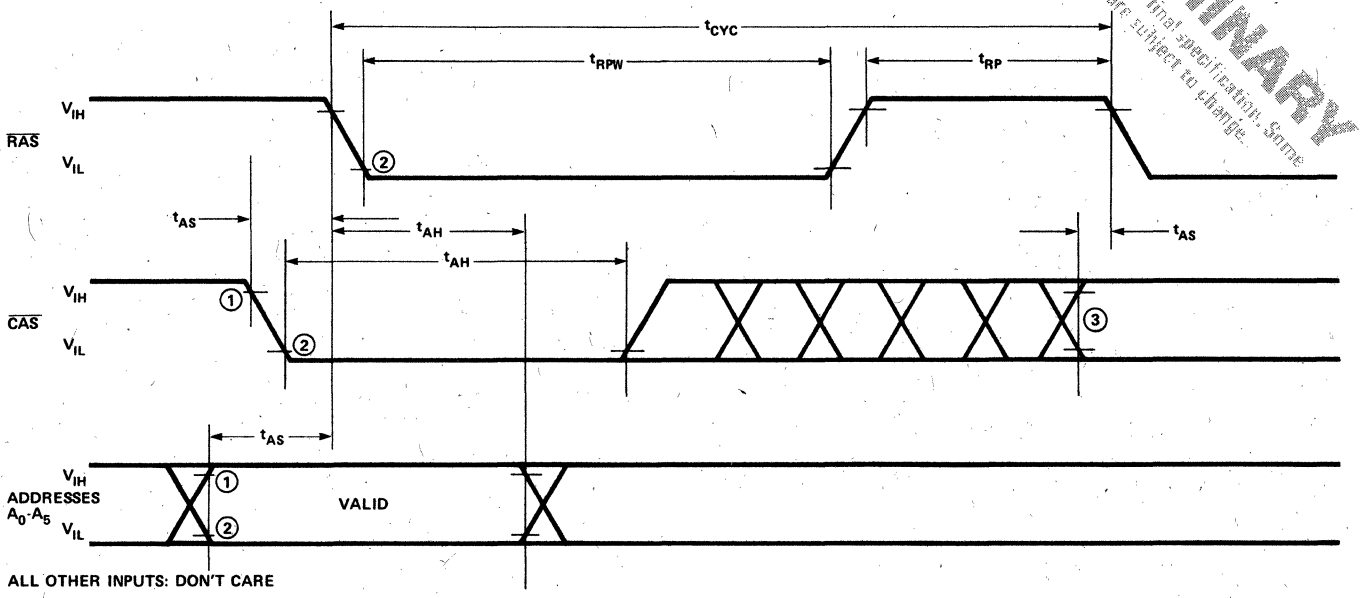
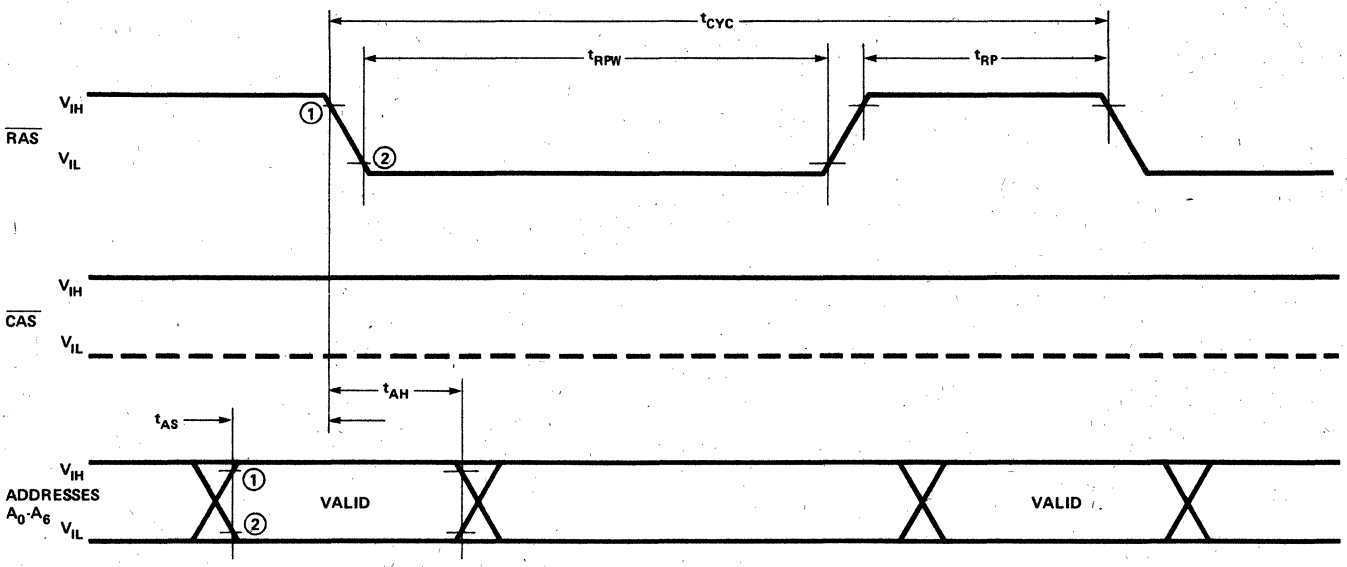
Refresh Cycle Waveforms

$\overline{CAS}$ BEFORE $\overline{RAS}$ CYCLES. (64 CYCLE REFRESH)



$\overline{RAS}$ ONLY CYCLES (128 CYCLE REFRESH)



Notes: 1,2. V_{IHMIN} and V_{ILMAX} are reference levels for measuring timing of input signals.
3. $\overline{CAS}$ must be high or low as appropriate for the next cycle.

Applications Information

REFRESH MODES

The 2116 may be refreshed in any of three modes. Read/Refresh cycles and $\overline{RAS}$-only cycles refresh the row addressed by A_0 through A_6 and therefore require 128 cycles to refresh the stored data. Assuming a 500 nsec system cycle time, the refresh operations require 64 μsec out of each 2.0 msec refresh period or 3.2% of the available memory time. The third 2116 refresh mode, $\overline{CAS}$-before-$\overline{RAS}$, allows refresh of the stored data in only 64 cycles and requires only 32 μsec or 1.6% of the available memory time (equal to the 64-cycle refresh 4K RAMs). While some 2116 aplications would not be impacted by the 3.2% memory lockout time using 128 cycle refresh, most large mainframe memory applications would suffer throughput degradation in that refresh mode. Intel designed the 2116 to allow either 128-cycle or 64-cycle refresh, allowing the system designer to choose the refresh mode which fits his system needs. In addition to allowing higher memory throughput, the $\overline{CAS}$-before-RAS 64-cycle refresh mode dissipates approximately 14% less power than the 128-cycle $\overline{RAS}$-only mode and 23% less power than the 128-cycle Read/Refresh mode (refer to the Standby Power Calculation section).

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PRELIMINARY

POWER SUPPLY DECOUPLING/ DISTRIBUTION

Power supply current waveforms for the 2116 are shown in Figure 3. The V_{DD} supply provides virtually all of the operating current for the 2116 with the V_{BB} supply providing only leakage currents. The V_{DD} supply current, I_{DD}, has two components; transient current peaks when the clocks change state and a DC component while the clocks are active (low). When selecting the decoupling capacitors for the V_{DD} supply, the characteristics of capacitors as well as the current waveform must be considered. Suppression of transient or pulse currents require capacitors with small physical size and low inherent inductance. Monolithic and other ceramic capacitors exhibit these desirable characteristics. When the current waveform indicates a DC component, bulk capacity must be located near the current load to supply the load power. Inductive effects of PC board traces and bus bars preclude supplying the DC component from bulk capacitors at the periphery of a memory matrix without voltage droop during the active portion of a memory cycle. This means that some bulk capacity in the form of electrolytic or large ceramic capacitors should be distributed around or within the memory matrix.

The V_{BB} supply current, I_{BB}, has high transient current peaks, with essentially no DC component (less than 100 microamperes). The V_{BB} capacitors should be selected for transient suppression characteristics. The following capacitance values and locations are recommended for the 2116:

1. A 1.0 μF ceramic capacitor (or a 1.0 μF electrolytic in parallel with a 0.01 μF ceramic capacitor) between V_{DD} and V_{SS} (ground) at every other device.
2. A 0.1 μF ceramic capacitor between V_{BB} and V_{SS} at every other device (preferably alternate devices to the V_{DD} decoupling above).
3. A 4.7 μF electrolytic capacitor between V_{DD} and V_{SS} for each eight devices and located adjacent to the devices.

The V_{CC} supply is connected only to the 2116 output buffer and is not used internally. The load current from the V_{CC} supply is dependent only upon the output loading and is usually only the input high level current to a TTL gate and the output leakage currents of any OR-tied 2116s (typically 100 μA or less total). Intel recommends that a 0.1 or 0.01 μF ceramic capacitor be connected between V_{CC} and V_{SS} for every eight devices to preclude coupled noise from affecting the TTL devices in the system.

Power supply noise levels should be maintained below the following values:

V_{DD} —300 mV peak-to-peak with a maximum excursion of 200 mV from the nominal supply level. The maximum allowable DC level shift during the cycle is 100 mV from the nominal supply level.

V_{BB} —200 mV peak-to-peak with a maximum excursion of 150 mV from the nominal supply level.

Intel recommends either a multilayer or a double-sided PC board layout with a power supply distribution system such that each power supply is grided both horizontally and vertically at each memory device. This technique minimizes the power distribution system impedance and enhances the effect of the decoupling capacitors.

OUTPUT DATA LATCH

The 2116 contains an output data latch eliminating the need for an external system data latch and the timing circuitry required to strobe an external latch. The output latch operates identically to the 16-pin 4K RAM (Intel 2104) output latch enhancing the system compatibility of the 16K and 4K devices.

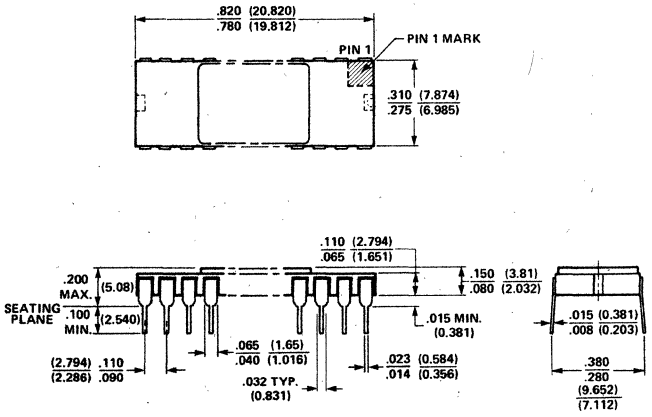
Operation of the output latch is controlled by $\overline{CAS}$. The data output will go to the high-impedance state immediately following the $\overline{CAS}$ leading edge during each data cycle and will either go to valid data at access time on selected devices (devices receiving both $\overline{RAS}$ and $\overline{CAS}$) or will remain in the high impedance state on unselected devices (devices receiving only $\overline{CAS}$). During $\overline{RAS}$-only refresh cycles, the data output remains in the state it was prior to the $\overline{RAS}$-only cycle. This unique feature of latched output RAMs allows a refresh cycle to be hidden among data cycles without impacting data availability. For instance, a $\overline{RAS}$-only refresh cycle could follow each data cycle in a microprocessor system but the accessed data would remain at the device output and the microprocessor could take the data at any time within the cycle. Non-latched output devices do not provide this type of hidden refresh capability since their data output would go to the high impedance state at the end of the data cycle.

PAGE MODE OPERATION

The 2116 is designed for page mode operation and is presently being characterized for that mode. Specifications will be available at a later date.

Packaging Information

16-LEAD HERMETIC DUAL IN-LINE PACKAGE



INTEL CORPORATION, 3065 Bowers Avenue,
Santa Clara, California 95051 (408) 246-7501

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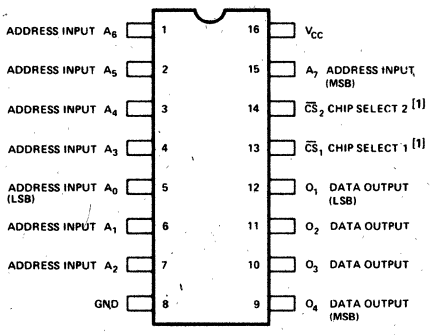
intel® Schottky Bipolar 3601, 3621

HIGH SPEED 1K (256 x 4) PROM

- **Fast Access Time — 50 nsec Maximum (3601-1, 3621-1)**
- **Fast Programming — 1 ms/bit Typically**
- **Three State Outputs (3621)**
- **Open Collector Outputs (3601)**
- **Standard Packaging — 16 Pin Hermetic Dual In-Line Lead Configuration**

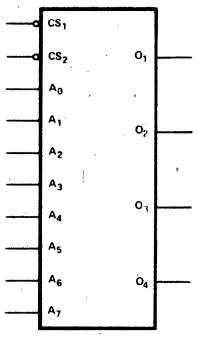
The 3601 and 3621 PROM families are organized as 256 words by 4-bits. The 3601 family is manufactured with all outputs initially low and the 3621 family with all outputs initially high.

PIN CONFIGURATION



NOTE 1. DURING PROGRAMMING THE PROGRAM PULSE MAY BE APPLIED TO EITHER $\overline{CS}_1$ OR $\overline{CS}_2$ FOR THE 3621 FAMILY ONLY.

LOGIC SYMBOL



ABSOLUTE MAXIMUM RATINGS*

Temperature Under Bias	-65°C to +150°C
Storage Temperature	-65°C to +160°C
Output or Supply Voltages	-0.5V to 7 Volts
All Input Voltages	-1.6V to 5.5V
Output Currents	100mA

*COMMENT

Stresses above those listed under "Absolute Maximum Rating" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or at any other condition above those indicated in the operational sections of this specification is not implied.

D.C. Characteristics: All limits apply for V_{CC} = +5.0V ± 5%, T_A = 0°C to +75°C, unless otherwise specified.

Symbol	Parameter	Limits Min.	Typ.[1]	Max.	Unit	Test Conditions
I_{FA}	Address Input Load Current		-0.05	-0.25	mA	V_{CC} = Max., V_A = 0.45V
I_{FS}	Chip Select Input Load Current		-0.05	-0.25	mA	V_{CC} = Max., V_S = 0.45V
I_{RA}	Address Input Leakage Current			40	μA	V_{CC} = Max., V_A = Max.
I_{RS}	Chip Select Input Leakage Current			40	μA	V_{CC} = Max., V_S = Max.
V_{CA}	Address Input Clamp Voltage		-0.9	-1.5	V	V_{CC} = Min., I_A = -10mA
V_{CS}	Chip Select Input Clamp Voltage		-0.9	-1.5	V	V_{CC} = Min., I_S = -10mA
V_{OL}	Output Low Voltage		0.3	0.45	V	V_{CC} = Min., I_{OL} = 15mA
I_{CC}	Power Supply Current		90	130	mA	V_{CC} = Max. $V_{A0} \rightarrow V_{A7}$ = 0V $\overline{CS_1}$ = $\overline{CS_2}$ = 0V
V_{IL}	Input "Low" Voltage			0.85	V	V_{CC} = 5.0V
V_{IH}	Input "High" Voltage	2.0			V	V_{CC} = 5.0V
I_{CEX}[2]	Output Leakage Current			100	μA	V_{CC} = Max., V_{CE} = Max.
$\|I_O\|$[3]	Output Leakage for High Impedance Stage			40	μA	V_O = Max., or 0.45V, V_{CC} = 5.25V, $\overline{CS_1}$ = $\overline{CS_2}$ = 2.4V
I_{SC}[3,4]	Output Short Circuit Current	-15		-60	mA	V_{CC} = 5.00V, T_A = 25°C, V_O = 0V
V_{OH}[3]	Output High Voltage	2.4			V	I_{OH} = -2.4mA, V_{CC} = Min.

NOTES: 1. Typical values are at 25°C and at nominal voltage.
2. This specification only applies to the 3601 family.
3. This specification only applies to the 3621 family.
4. Unmeasured outputs are open during this test.

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A. C. Characteristics V_{CC} = +5V ±5%, T_A = 0°C to + 75°C

SYMBOL	PARAMETER	MAXIMUM LIMITS			UNIT	CONDITIONS
		0°C	25°C	75°C		
t_{A++}, t_{A--} t_{A+-}, t_{A-+}	Address to Output Delay (3601, 3621)	70	60	70	ns	Both C.S. lines must be at ground potential to activate the PROM.
t_{A++}, t_{A--} t_{A+-}, t_{A-+}	Address to Output Delay (3601-1, 3621-1)	50	50	50	ns	
t_{S++}, t_{S--}	Chip Select to Output Delay	25	25	25	ns	

Capacitance [1] T_A = 25°C

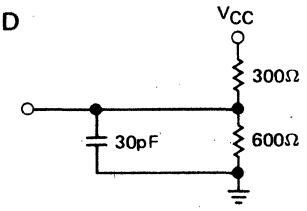
SYMBOL	PARAMETER	LIMITS		UNIT	TEST CONDITIONS
		TYP.	MAX.		
C_{INA}	Address Input Capacitance	4	10	pF	V_{CC} = 5V V_{IN} = 2.5V
C_{INS}	Chip-Select Input Capacitance	6	10	pF	V_{CC} = 5V V_{IN} = 2.5V
C_{OUT}	Output Capacitance	7	12	pF	V_{CC} = 5V V_{OUT} = 2.5V

NOTE 1: This parameter is only periodically sampled and is not 100% tested.

Switching Characteristics

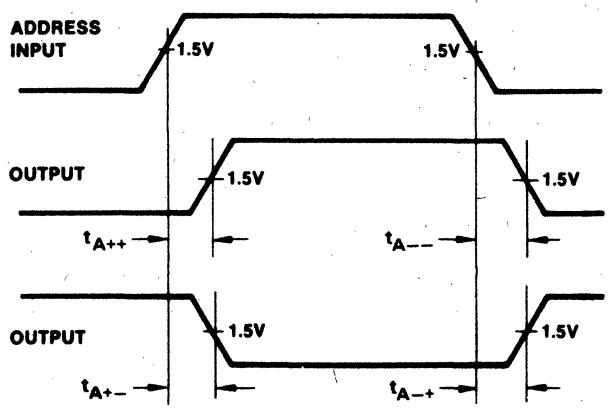
Conditions of Test:
Input pulse amplitudes - 2.5V
Input pulse rise and fall times of
5 nanoseconds between 1 volt and 2 volts
Speed measurements are made at 1.5 volt levels
Output loading is 15 mA and 30 pF
Frequency of test - 2.5 MHz

15 mA TEST LOAD

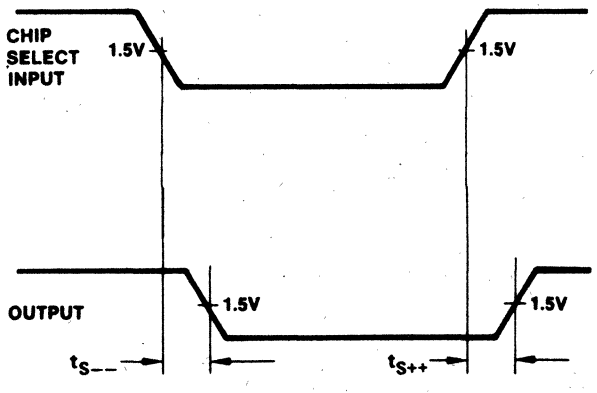


Waveforms

ADDRESS TO OUTPUT DELAY



CHIP SELECT TO OUTPUT DELAY



Intel

MEMORY

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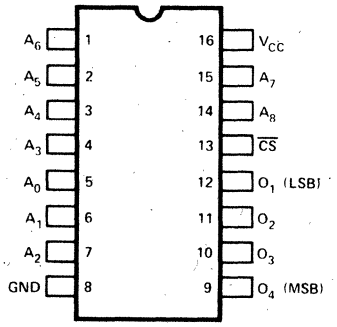
intel® Schottky Bipolar 3602, 3602-4, 3602L-6, 3622, 3622-4, 3622L-6

HIGH SPEED 2K (512 x 4) PROM

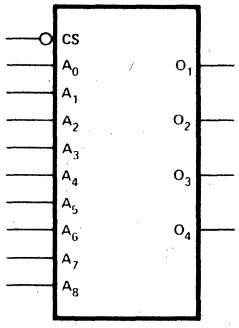
- **Fast Access Time — 70ns (3602, 3622)**
- **Low Standby Power Dissipation (3602L-6, 3622L-6) — 115 μW/bit**
- **Open Collector (3602, 3602-4, 3602L-6) or Three-State (3622, 3622-4, 3622L-6) Outputs**

The 3602 and 3622 families are 512 words by 4 bit PROMs. The PROMs are manufactured with all outputs high and logic low levels can be electrically programmed in selected bit locations.

PIN CONFIGURATION



LOGIC SYMBOL



ABSOLUTE MAXIMUM RATINGS*

Temperature Under Bias	-65°C to +150°C
Storage Temperature	-65°C to +160°C
Output or Supply Voltages	-0.5V to 7 Volts
All Input Voltages	-1.6V to 5.6V
Output Currents	100mA

*COMMENT

Stresses above those listed under "Absolute Maximum Rating" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or at any other condition above those indicated in the operational sections of this specification is not implied.

D. C. Characteristics: All Limits Apply for V_{CC} = +5V ±5%, T_A = 0°C to +75°C, unless otherwise specified.

Symbol	Parameter	Limits Min.	Typ.[1]	Max.	Unit	Test Conditions
I_{FA}	Address Input Load Current		-0.05	-0.25	mA	V_{CC} = 5.25V, V_A = 0.45V
I_{FS}	Chip Select Input Load Current		-0.05	-0.25	mA	V_{CC} = 5.25V, V_S = 0.45V
I_{RA}	Address Input Leakage Current			40	μA	V_{CC} = 5.25V, V_A = 5.25V
I_{RS}	Chip Select Input Leakage Current			40	μA	V_{CC} = 5.25V, V_S = 5.25V
V_{CA}	Address Input Clamp Voltage		-0.9	-1.5	V	V_{CC} = 4.75V, I_A = -10mA
V_{CS}	Chip Select Input Clamp Voltage		-0.9	-1.5	V	V_{CC} = 4.75V, I_S = -10mA
V_{OL}	Output Low Voltage		0.3	0.45	V	V_{CC} = 4.75V, I_{OL} = 15mA
I_{CEX}[2]	Output Leakage Current			100	μA	V_{CC} = 5.25V, V_{CE} = 5.25V
I_{CC1}	Power Supply Current (3602, 3602-4, 3622, 3622-4)			140	mA	V_{CC}=5.25V, V_{A0}→V_{A8} = 0V $\overline{CS}$ = 0V
I_{CC2}	Power Supply Current (3602L-6, 3622L-6) Active			110	mA	V_{CC}=5.25V $\overline{CS}$ = 0.45V
	Standby			45	mA	$\overline{CS}$ = 2.4V
V_{IL}	Input "Low" Voltage			0.85	V	V_{CC} = 5.0V
V_{IH}	Input "High" Voltage	2.0			V	V_{CC} = 5.0V
$\|I_O\|$[3]	Output Leakage for High Impedance Stage			40	μA	V_O=5.25V or 0.45V, V_{CC}=5.25V, $\overline{CS}$=2.4V
I_{SC}[3,4]	Output Short Circuit Current	-15	-25	-60	mA	V_{CC}=5.00V, T_A=25°C, V_O = 0V
V_{OH}[3]	Output High Voltage	2.4			V	I_{OH}=-2.4mA, V_{CC} = 4.75V

NOTES: 1. Typical values are at 25 C and at nominal voltage.
2. This specification only applies to the 3602 family.
3. This specification only applies to the 3622 family.
4. Unmeasured outputs are open during this test.

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A. C. Characteristics V_{CC} = +5V ±5%, T_A = 0°C to +75°C

SYMBOL	PARAMETER	MAX. LIMIT 3602 3622	MAX. LIMIT 3602-4 3622-4	MAX. LIMIT 3602L-6 3622L-6	UNIT	CONDITIONS
t_{A++}, t_{A--} t_{A+-}, t_{A-+}	Address to Output Delay	70	90	90	ns	$\overline{CS}$ = V_{IL} to Select the PROM
t_{S++}	Chip Select to Output Delay	30	30	30	ns	
t_{S--}	Chip Select to Output Delay	30	30	120	ns	

Capacitance [1] T_A = 25°C, f = 1 MHz

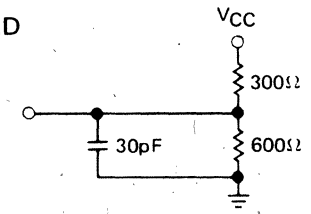
SYMBOL	PARAMETER	LIMITS TYP.	LIMITS MAX.	UNIT	TEST CONDITIONS
C_{INA}	Address Input Capacitance	4	10	pF	V_{CC} = 5V V_{IN} = 2.5V
C_{INS}	Chip-Select Input Capacitance	6	10	pF	V_{CC} = 5V V_{IN} = 2.5V
C_{OUT}	Output Capacitance	7	12	pF	V_{CC} = 5V V_{OUT} = 2.5V

NOTE 1: This parameter is only periodically samp'ed and is not 100% tested.

Switching Characteristics

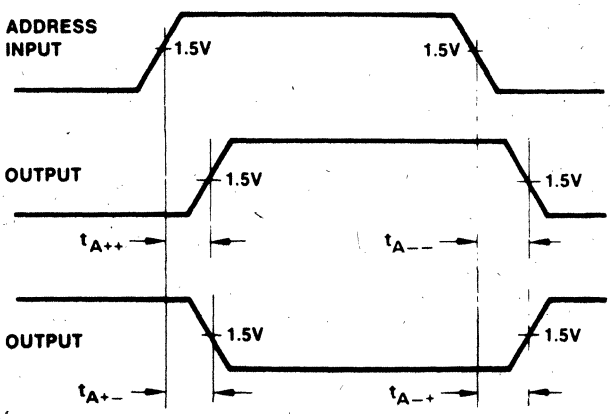
Conditions of Test:
Input pulse amplitudes - 2.5V
Input pulse rise and fall times of
5 nanoseconds between 1 volt and 2 volts
Speed measurements are made at 1.5 volt levels
Output loading is 15 mA and 30 pF
Frequency of test - 2.5 MHz

15 mA TEST LOAD

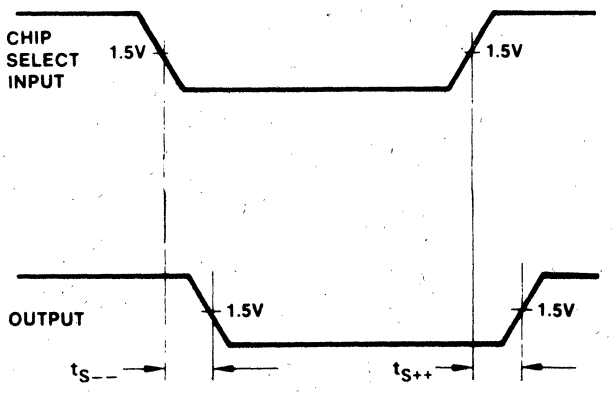


Waveforms

ADDRESS TO OUTPUT DELAY



CHIP SELECT TO OUTPUT DELAY



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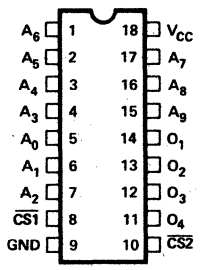
3605, 3625
HIGH SPEED 1K x 4 PROM

3605-2, 3625-2	60 ns Max.
3605, 3625	70 ns Max.

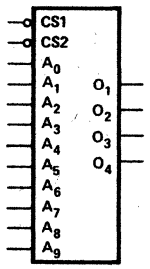
- **Fast Access Time: 45ns Typically**
- **Low Power Dissipation: 0.14 mW/bit Typically**
- **Open Collector (3605) and Three-State (3625) Outputs**
- **Hermetic 18 Pin DIP**

The 3605/3625 is a high density 4096 bit PROM suitable for uses where fast turnaround and pattern experimentation are important such as in prototypes or in small production volume systems. The PROMs are manufactured with all outputs high and logic low levels can be electrically programmed in selected bit locations.

PIN CONFIGURATION



LOGIC SYMBOL



Absolute Maximum Ratings*

Temperature Under Bias	-10°C to +85°C
Storage Temperature	-65°C to +160°C
Output or Supply Voltages	-0.5V to 7 Volts
All Input Voltages	-1V to 5.5V
Output Currents	100 mA

***COMMENT**

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the deivce at these or at any other condition above those indicated in the operational sections of this specification is not implied.

D.C. Characteristics All Limits Apply for V_{CC}= +5.0V ±5%, T_A= 0°C to +75°C

Symbol	Parameter	Limits Min.	Typ.[1]	Max.	Unit	Test Conditions
I_{FA}	Address Input Load Current		-0.05	-0.25	mA	V_{CC}=5.25V, V_A=0.45V
I_{FS}	Chip Select Input Load Current		-0.05	-0.25	mA	V_{CC}=5.25V, V_S=0.45V
I_{RA}	Address Input Leakage Current			40	μA	V_{CC}=5.25V, V_A=5.25V
I_{RS}	Chip Select Input Leakage Current			40	μA	V_{CC}=5.25V, V_S=5.25V
V_{CA}	Address Input Clamp Voltage		-0.9	-1.5	V	V_{CC}=4.75V, I_A=-10mA
V_{CS}	Chip Select Input Clamp Voltage		-0.9	-1.5	V	V_{CC}=4.75V, I_S=-10mA
V_{OL}	Output Low Voltage		0.3	0.45	V	V_{CC}=4.75V, I_{OL}=15mA
I_{CEX}	3605 Output Leakage Current			100	μA	V_{CC}=5.25V, V_{CE}=5.25V
I_{CC}	Power Supply Current		110	150	mA	V_{CC} = 5.25V, $V_{A0}\rightarrow V_{A9}$=0V, $\overline{CS}_1=\overline{CS}_2=V_{IH}$
V_{IL}	Input "Low" Voltage			0.85	V	V_{CC}=5.0V
V_{IH}	Input "High" Voltage	2.0			V	V_{CC}=5.0V

3625, 3625-2 ONLY

Symbol	Parameter	Min.	Typ.[1]	Max.	Unit	Test Conditions
$\|I_O\|$	Output Leakage for High Impedance Stage			100	μA	V_O=5.25V or 0.45V, V_{CC}=5.25V, $\overline{CS}_1=\overline{CS}_2$=2.4V
I_{SC}[2]	Output Short Circuit Current	-15	-25	-60	mA	V_O = 0V
V_{OH}	Output High Voltage	2.4			V	I_{OH}=-2.4mA, V_{CC} = 4.75V

NOTES: 1. Typical values are at 25°C and at nominal voltage. 2. Unmeasured outputs are open during this test.

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A.C. Characteristics V_{CC} = +5V ±5%, T_A = 0°C to +75°C

Symbol	Parameter	Max. Limits 3605-2 3625-2	Max. Limits 3605 3625	Unit	Conditions
t_{A++}, t_{A--} t_{A+-}, t_{A-+}	Address to Output Delay	60	70	ns	$\overline{CS}_1=\overline{CS}_2=V_{IL}$ to select the PROM.
t_{S++}	Chip Select to Output Delay	30	30	ns	
t_{S--}	Chip Select to Output Delay	30	30	ns	

Capacitance [1] T_A = 25°C, f = 1 MHz

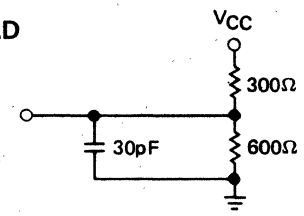
SYMBOL	PARAMETER	LIMITS TYP.	LIMITS MAX.	UNIT	TEST CONDITIONS
C_{INA}	Address Input Capacitance	4	10	pF	V_{CC} = 5V V_{IN} = 2.5V
C_{INS}	Chip-Select Input Capacitance	6	10	pF	V_{CC} = 5V V_{IN} = 2.5V
C_{OUT}	Output Capacitance	7	12	pF	V_{CC} = 5V V_{OUT} = 2.5V

NOTE 1: This parameter is only periodically sampled and is not 100% tested.

Switching Characteristics

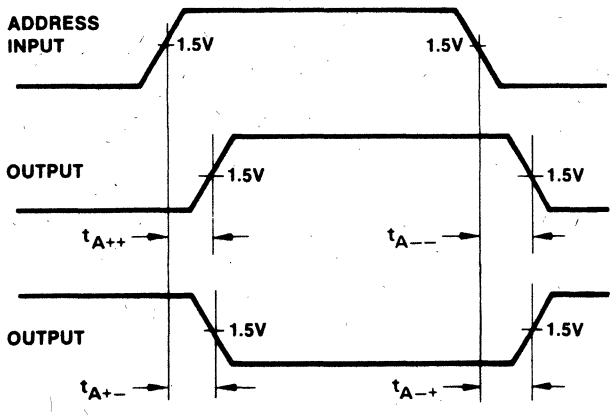
Conditions of Test:
Input pulse amplitudes - 2.5V
Input pulse rise and fall times of
5 nanoseconds between 1 volt and 2 volts
Speed measurements are made at 1.5 volt levels
Output loading is 15 mA and 30 pF
Frequency of test - 2.5 MHz

15mA TEST LOAD

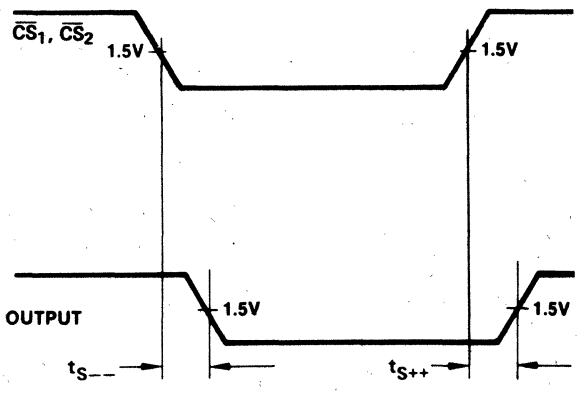


Waveforms

ADDRESS TO OUTPUT DELAY



CHIP SELECT TO OUTPUT DELAY



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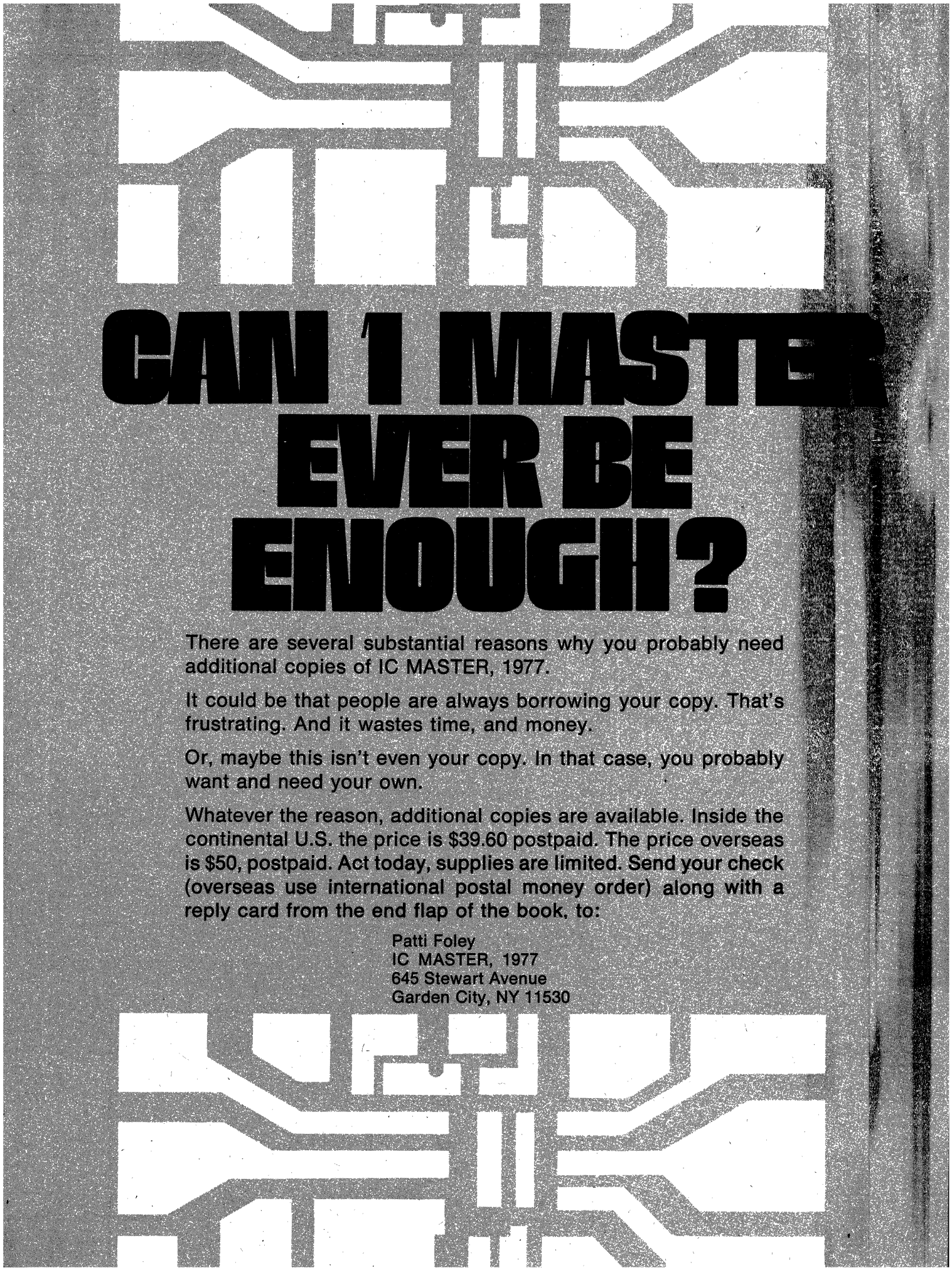

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NATIONAL SEMICONDUCTOR BIPOLAR PROM/ROM SELECTION GUIDE

TOTAL BITS	PART NUMBER		ORGANIZATION	NUMBER OF PINS	TEMPERATURE RANGE	MAXIMUM ADDRESS ACCESS (t_{AA})	MAXIMUM SUPPLY CURRENT (I_{CC})
	PROM	ROM					
256	DM7577	DM5488	32 x 8 OC	16	−55°C to +125°C	70	110
	DM8577	DM7488	32 x 8 OC	16	0°C to +70°C	50	110
	DM7578	DM5798	32 x 8 TS	16	−55°C to +125°C	70	110
	DM8578	DM8598	32 x 8 TS	16	0°C to +70°C	50	110
1024	DM54S387	DM54S187	256 x 4 OC	16	−55°C to +125°C	60	130
	DM74S387	DM74S187	256 x 4 OC	16	0°C to +70°C	50	130
	DM54S287	DM75S97	256 x 4 TS	16	−55°C to +125°C	60	130
	DM74S287	DM85S97	256 x 4 TS	16	0°C to +70°C	50	130
2048	DM54S570	DM54S270	512 x 4 OC	16	−55°C to +125°C	70	130
	DM74S570	DM74S270	512 x 4 OC	16	0°C to +70°C	55	130
	DM54S571	DM54S370	512 x 4 TS	16	−55°C to +125°C	70	130
	DM74S571	DM74S370	512 x 4 TS	16	0°C to +70°C	55	130
2048	DM77S221	DM77S201	256 x 8 OC	20	−55°C to +125°C	75	150
	DM87S221	DM87S201	256 x 8 OC	20	0°C to +70°C	60	150
	DM77S222	DM77S202	256 x 8 TS	20	−55°C to +125°C	75	150
	DM87S222	DM87S202	256 x 8 TS	20	0°C to +70°C	60	150
2048	DM54S470	DM54S271	256 x 8 OC	20	−55°C to +125°C	75	150
	DM74S470	DM74S271	256 x 8 OC	20	0°C to +70°C	60	150
	DM54S471	DM54S371	256 x 8 TS	20	−55°C to +125°C	75	150
	DM74S471	DM74S371	256 x 8 TS	20	0°C to +70°C	60	150
4096	DM77S295	DM77S95	512 x 8 OC	24	−55°C to +125°C	80	170
	DM87S295	DM87S95	512 x 8 OC	24	0°C to +70°C	65	170
	DM77S296	DM77S96	512 x 8 TS	24	−55°C to +125°C	80	170
	DM87S296	DM87S96	512 x 8 TS	24	0°C to +70°C	65	170
4096	DM54S473		512 x 8 OC	20	−55°C to +125°C	80	165
	DM74S473		512 x 8 OC	20	0°C to +70°C	65	165
	DM54S472		512 x 8 TS	20	−55°C to +125°C	80	165
	DM74S472		512 x 8 TS	20	0°C to +70°C	65	165
4096	DM54S572		1k x 4 OC	18	−55°C to +125°C	75	140
	DM74S572		1k x 4 OC	18	0°C to +70°C	60	140
	DM54S573		1k x 4 TS	18	−55°C to +125°C	75	140
	DM74S573		1k x 4 TS	18	0°C to +70°C	60	140
8192	DM77S229	DM75S29	1k x 8 OC	24	−55°C to +125°C	90	170
	DM87S229	DM85S29	1k x 8 OC	24	0°C to +70°C	70	170
	DM77S228	DM75S28	1k x 8 TS	24	−55°C to +125°C	90	170
	DM87S228	DM85S28	1k x 8 TS	24	0°C to +70°C	70	170

Note. All PROMS are direct equivalents to their respective ROMS.

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NATIONAL SEMICONDUCTOR BIPOLAR PROM CROSS REFERENCE GUIDE

SIZE AND ORGANIZATION	OUTPUT	NATIONAL MIL/COM	AMD M = MIL C = COM	FAIRCHILD M = MIL C = COM	HARRIS 2 = MIL 5 = COM	INTEL M = MIL P = COM	INTERSIL M = MIL C = COM	M.M.I. MIL/COM -1 = SCHOTTKY	SIGNETICS S = MIL N = COM	T.I. MIL/COM
256-Bit (32 x 8) 16-Pin	OC	DM7577/DM8577	AM27S08		HM1-7602 HM1-8256		IM5600	5330/6330	8223 82S23	SN54188A/74188A SN54S188/74S188
	TS	DM7578/DM8578	AM27S09		HM1-7603		IM5610	5331/6331	82S123	SN54S288/74S288
1024-Bit (256 x 4) 16-Pin	OC	DM54S387/DM74S387 DM7573/DM8573	AM27S10	93417 93416	HM1-7610 HM1-1024	3601-1 3601	IM5603	5300/6300	82S126	SN54S387/74S387
	TS	DM54S287/DM74S287 DM7574/DM8574	AM27S11	93427 93426	HM1-7611 HM1-1024A	3621	IM5623	5301/6301	82S129	SN54S287/74S287
2048-Bit (512 x 4) 16-Pin	OC	DM54S570/DM74S570		93436	HM1-7620	3602	IM5604	5305/6305	82S130	
	TS	DM54S571/DM74S571		93446	HM1-7621	3622	IM5624	5306/6306	82S131	
4096-Bit (512 x 8) 24-Pin	OC	DM77S295/DM87S295		93438	HM1-7640	3604	IM5605	5340/6340	82S140	
	TS	DM77S296/DM87S296		93448	HM1-7641	3624	IM5625	5341/6341	82S141	
2048-Bit (256 x 8) 20-Pin	OC	DM54S470/DM74S470*								SN54S470/74S470
	TS	DM54S471/DM74S471*								SN54S471/74S471
4096-Bit (512 x 8) 20-Pin	OC	DM54S473/DM74S473*								SN54S473/74S473
	TS	DM54S472/DM74S472*								SN54S472/74S472
4096-Bit (1024 x 4) 18-Pin	OC	DM54S572/DM74S572*		93452	HM1-7642	3605	IM5606	5352/6352	82S136	
	TS	DM54S573/DM74S573*		93453	HM1-7643	3625	IM5626	5353/6353	82S137	
8192-Bit (1024 x 8) 24-Pin	OC	DM75S229/DM85S229*						5380/6380	82S180	
	TS	DM75S228/DM85S228*						5381/6381	82S181	

*Future products

Note: All manufacturer's PROMs program differently.

NATIONAL SEMICONDUCTOR BIPOLAR RAM CROSS REFERENCE GUIDE

SIZE AND ORGANIZATION	OUTPUT	NATIONAL MIL/COM	AMD M = MIL C = COM	F.S.C. M = MIL C = COM	INTEL M = MIL P = COM	INTERSIL M = MIL P = COM	MMI MIL/COM	SIGNETICS S = MIL N = COM	T.I. MIL/COM
64-Bit (16 x 4)	OC	DM5489/DM7489	AM3101		3101	IM5501		8225	SN5489/7489
	TS	DM7599/DM8599							
High Speed 64-Bit (16 x 4)	OC	DM54S289/DM74S289	AM27S02	93403	3101A		5560/6560	82S25	SN54S289/74S289
	TS	DM54S189/DM74S189	AM27S03				5561/6561		SN54S189/74S189
Low Power 64-Bit (16 x 4)	OC	DM54LS289/DM74LS289	AM27LS02				L5560/L6560		
	TS	DM54LS189/DM74LS189	AM27LS03				L5561/L6561		
File Reg. (16 x 4)	TS	DM75S68/DM85S68							
256-Bit (256 x 1)	OC	DM54S206/DM74S206	AM27S01	93411 93411A	3107 3107A	IM5533A	5530/6530	82S07 82S17 82S117	SN54S301/74S301
	TS	DM54S200/DM74S200	AM27S00	93421 93421A	3106 3106A	IM5523A	5531/6531	82S06 82S16 82S116	SN54200/74200 SN54S200/74S200 SN54S201/74S201
1024-Bit (1024 x 1)	OC	DM93415AM/DM93415AC		93415 93415A		IM5508 IM5508A		82S10	SN54S309/74S309
	TS	DM93425AM/DM93425AC		93425 93425A		IM5518 IM5518A		82S11	SN54S209/74S209

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National Semiconductor

PROM programming procedure

These parts are shipped from the factory with all fuses intact. As a result, the outputs will be low (logical "0") for all addresses. In order to generate a high level on the outputs, the part must be programmed. Information on available programming equipment may be obtained from National. However, if it is desired to build your own programmer, the following conditions must be observed.

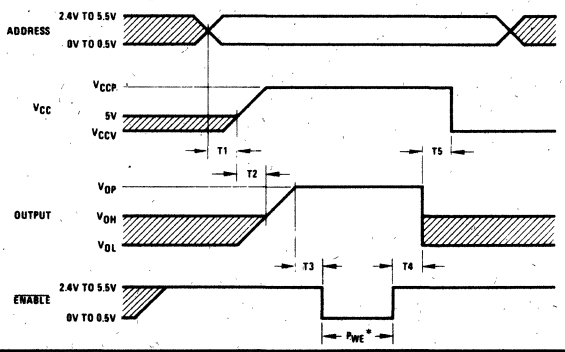
1. Programming should be attempted only at temperatures between 15°C and 30°C.
2. Addresses and chip enable pins must be driven from normal TTL logic levels during both programming and verification.
3. Programming will occur at a selected address when V_{CC} is held at 10.5V, the appropriate output is held at 10.5V and the chip is subsequently enabled. To achieve these conditions in the appropriate sequence, the following procedure must be followed:
   a) Select the desired word by applying a high or low level to the appropriate address inputs. Disable the chip by applying a high level to one or both enable inputs.
   b) Increase V_{CC} to 10.5V ±0.5V with the rate of increase being between 1.0 and 10.0V/μs. Since V_{CC} supplies the current to program the fuse as well as the I_{CC} of the device at programming voltage, it must be capable of supplying 400 mA at 11.0V.
   c) Select the output where a high level is desired by raising that output voltage to 10.5V ±0.5V. Limit the rate of increase to a value between 1.0 and 10.0V/μs. This voltage change may occur simultaneously with the increase in V_{CC} but must not precede it. It is critical that only one output at a time be programmed since the internal circuits can only supply programming current to one bit at a time. Outputs not being programmed must be left open or tied to a high impedance source of at least 20 kΩ. (Remember that the outputs of the device are still disabled at this time because the chip enables are high.)
   d) Enable the device by taking both chip enables to a low level. This is done with a pulse of 10μs. The 10μs duration refers to the time that the circuit is enabled. Normal input levels are used and rise and fall times are not critical.
   e) Verify that the bit has been programmed by first removing the programming voltage from the output and then reducing V_{CC} to 4.0V ±0.2V. Verification at a V_{CC} level of 4.0V will guarantee proper output states over the V_{CC} and temperature range of the programmed part. The chip must be enabled to sense the state of the outputs. During verification, the loading of the output must be within specified I_{OL} and I_{OH} limits. Steps b, c and d must be repeated 10 times or until verification that the bit has programmed.
   f) Following verification, apply five additional programming pulses to the bit being programmed. The programming procedure is now complete for the selected bit.
   g) Repeat steps a through f for each bit to be programmed to a high level. If the procedure is performed on an automatic programmer, the duty cycle of V_{CC} at programming voltage must be limited to a maximum of 25%. This is necessary to minimize chip junction temperatures. After all selected bits are programmed, the entire contents of the memory should be verified.

Note: Since only an enabled chip is programmed, it is possible to program these parts at the board level if all programming parameters are complied with.

Programming Parameters Do not test or you may program the device.

PARAMETERS		CONDITIONS	MIN	RECOMMENDED VALUE	MAX	UNITS
V_{CCP}	Required V_{CC} for Programming		10.0	10.5	11.0	V
I_{CCP}	I_{CC} During Programming	V_{CC} = 11V			400	mA
V_{OP}	Required Output Voltage for Programming		10.0	10.5	11.0	V
I_{OP}	Output Current while Programming	V_{OUT} = 11V			20	mA
t_{RR}	Rate of Voltage Change of V_{CC} or Output		1.0		10.0	V/μs
P_{WE}	Programming Pulse Width (Enabled)		9	10	11	μs
V_{CCV}	Required V_{CC} for Verification		3.8	4.0	4.2	V
M_{DC}	Maximum Duty Cycle for V_{CC} at V_{CCP}			25	25	%

Programming Waveforms



T1 = 100 ns min
T2 = 5μs min (T2 may be ≥ 0 if V_{CCP} rises at the same rate or faster than V_{OP})
T3 = 100 ns min
T4 = 100 ns min
T5 = 100 ns min

*P_{WE} is repeated for 5 additional pulses after verification of V_{OH} indicates a bit has programmed

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Preliminary

DM54S188/DM74S188 open-collector 256-bit PROM
DM54S288/DM74S288 TRI-STATE® 256-bit PROM

general description

These Schottky PROM memories are organized in the popular 32 words by 8 bits configuration. A memory enable input is provided to control the output states. When the enable input is in the low state, the outputs present the contents of the selected word.

If the enable input is raised to a high level, it causes all 8 outputs to go to the "OFF" or high impedance state. The memories are available in both open-collector and TRI-STATE® versions and are available as ROM's as well as PROM's.

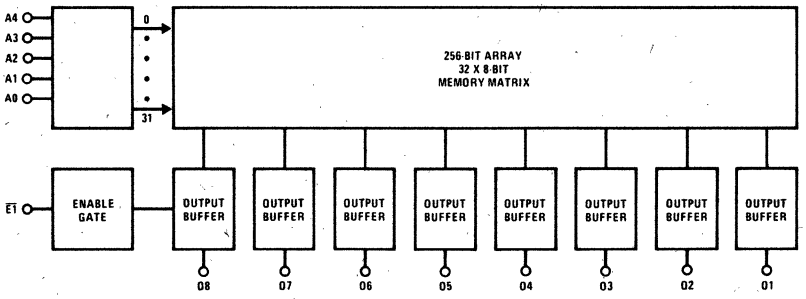
PROM's are shipped from the factory with lows in all locations. A high may be programmed into any selected location by following the programming instructions. Once programmed, it is impossible to go back to a low.

features

- Advanced titanium-tungsten (Ti-W) fuses
- Schottky-clamped for high speed
  Address access—30 ns max
  Enable access—20 ns max
- PNP inputs reduce input loading
- All dc and ac parameters guaranteed over temperature
- Low voltage TRI-SAFE™ programming
- Board level programming

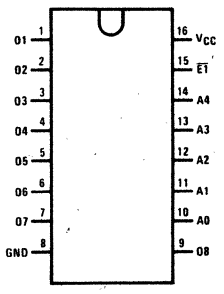
	Military	Commercial	Open-Collector	TRI-STATE	Package
DM74S188		X	X		N, J
DM74S288		X		X	N, J
DM54S188	X		X		J
DM54S288	X			X	J

block diagram



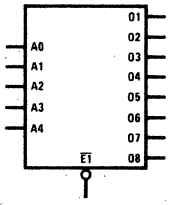
connection diagram

Dual-In-Line Package



TOP VIEW

logic symbol



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absolute maximum ratings (Note 1)

Supply Voltage (Note 2)	−0.5V to +7V
Input Voltage (Note 2)	−1.2V to +5.5V
Output Voltage (Note 2)	−0.5V to +5.5V
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM54S188, DM54S288	4.5	5.5	V
DM74S188, DM74S288	4.75	5.25	V
Ambient Temperature (T_A)			
DM54S188, DM54S288	−55	+125	°C
DM74S188, DM74S288	0	+70	°C
Logical "0" Input Voltage (Low)	0	0.8	V
Logical "1" Input Voltage (High)	2.0	5.5	V

dc electrical characteristics (Note 3)

PARAMETER		CONDITIONS	DM54S188, 54S288			DM74S188, 74S288			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{IL}	Input Load Current, All Inputs	V_{CC} = Max, V_{IN} = 0.45V		−80	−250		−80	−250	μA
I_{IH}	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 2.7V			25			25	μA
I_I	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 5.5V			1.0			1.0	mA
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA		0.35	0.5		0.35	0.5	V
V_{IL}	Low Level Input Voltage				0.80			0.80	V
V_{IH}	High Level Input Voltage		2.0			2.0			V
I_{CEX}	Output Leakage Current (Open-Collector Only) (Note 5)	V_{CC} = Max, V_{CEX} = 2.4V			50			50	μA
		V_{CC} = Max, V_{CEX} = 5.5V			100			100	μA
V_C	Input Clamp Voltage	V_{CC} = Min, I_{IN} = −18 mA		−0.8	−1.2		−0.8	−1.2	V
C_{IN}	Input Capacitance	V_{CC} = 5V, V_{IN} = 2V, T_A = 25°C, 1 MHz		4.0			4.0		pF
C_O	Output Capacitance	V_{CC} = 5V, V_O = 2V, T_A = 25°C, 1 MHz, Output "OFF"		6.0			6.0		pF
I_{CC}	Power Supply Current	V_{CC} = Max, All Inputs Grounded, All Outputs Open		70	110		70	110	mA
TRI-STATE PARAMETERS									
I_{SC}	Output Short Circuit Current (Note 5)	V_O = 0V, V_{CC} = Max, (Note 4)	−30	−60	−100	−30	−60	−100	mA
I_{HZ}	Output Leakage (TRI-STATE)	V_{CC} = Max, V_O = 0.45 to 2.4V, Chip Disabled			±50			±50	μA
V_{OH}	Output Voltage High, (Note 5)	I_{OH} = −2 mA	2.4	3.2					V
		I_{OH} = −6.5 mA				2.4	3.2		V

ac electrical characteristics (With standard load)

PARAMETER		CONDITIONS	DM54S188, 54S288 5V ±10%; −55°C to +125°C			DM74S188, 74S288 5V ±5%; 0°C to +70°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{AA}	Address Access Time			22	40		22	30	ns
t_{EA}	Enable Access Time			15	30		15	20	ns
t_{ER}	Enable Recovery Time			15	30		15	20	ns

Note 1: Absolute maximum ratings are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

Note 2: These limits do not apply during programming. For the programming ratings, refer to the programming instructions.

Note 3: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

Note 4: During I_{SC} measurement, only one output at a time should be grounded. Permanent damage may otherwise result.

Note 5: To measure V_{OH}, I_{CEX} or I_{SC} on an unprogrammed part, apply 10.5V to both A7 and A2 (pin 15 and pin 7).

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DM54S287/DM74S287 TRI-STATE® 1024-bit PROM
DM54S387/DM74S387 open-collector 1024-bit PROM

general description

These Schottky memories are organized in the popular 256 words by 4 bits configuration. Two memory enable inputs are provided to control the output states. When both enable inputs are in the low state, the outputs present the contents of the selected word.

If either or both of the enable inputs is raised to a high state, it causes all four outputs to go to the "OFF" or high impedance state. The memories are available in both open-collector and TRI-STATE versions and are available as ROM's as well as PROM's.

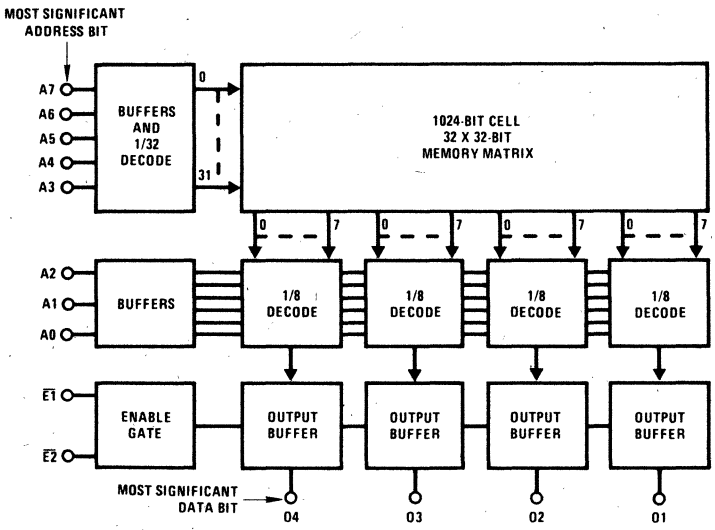
PROM's are shipped from the factory with lows in all locations. A high may be programmed into any selected location by following the programming instructions. Once programmed, it is impossible to go back to a low.

features

- Advanced titanium-tungsten (Ti-W) fuses
- Schottky-clamped for high speed
  Address access—50 ns max
  Enable access—25 ns max
- PNP inputs reduce input loading
- All dc and ac parameters guaranteed over temperature
- Low voltage TRI-SAFE™ programming
- Board level programming
- ROM mates are DM74S187 and DM85S97

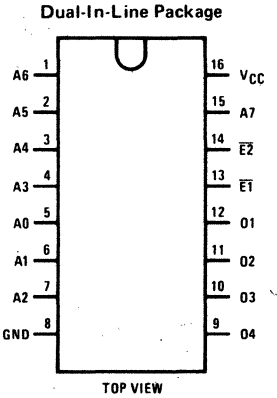
	Military	Commercial	Open-Collector	TRI-STATE	Package
DM74S387		X	X		N, J
DM74S287		X		X	N, J
DM54S387	X		X		J
DM54S287	X			X	J

block diagram



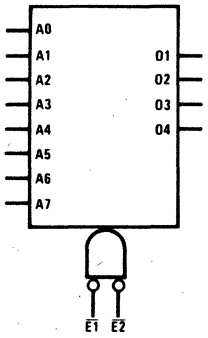
connection diagram

Dual-In-Line Package



TOP VIEW

logic symbol



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absolute maximum ratings (Note 1)

Supply Voltage (Note 2)	−0.5V to +7V
Input Voltage (Note 2)	−1.2V to +5.5V
Output Voltage (Note 2)	−0.5V to +5.5V
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM54S387, DM54S287	4.5	5.5	V
DM74S387, DM74S287	4.75	5.25	V
Ambient Temperature (T_A)			
DM54S387, DM54S287	−55	+125	°C
DM74S387, DM74S287	0	+70	°C
Logical "0" Input Voltage (Low)	0	0.8	V
Logical "1" Input Voltage (High)	2.0	5.5	V

dc electrical characteristics (Note 3)

PARAMETER		CONDITIONS	DM54S387/287			DM74S387/287			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
I_F	Input Load Current, All Inputs	V_{CC} = Max, V_F = 0.45V		−80	−250		−80	−250	μA
I_R	Input Leakage Current, All Inputs	V_{CC} = Max, V_R = 2.7V			25			25	μA
I_{RB}	Input Leakage Current, All Inputs	V_{CC} = Max, V_{RB} = 5.5V			1.0			1.0	mA
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA		0.35	0.5		0.35	0.5	V
V_{IL}	Low Level Input Voltage				0.80			0.80	V
V_{IH}	High Level Input Voltage		2.0			2.0			V
I_{CEX}	Output Leakage Current (Open-Collector Only) (Note 5)	V_{CC} = Max, V_{CEX} = 2.4V			50			50	μA
		V_{CC} = Max, V_{CEX} = 5.5V			100			100	μA
V_C	Input Clamp Voltage	V_{CC} = Min, I_{IN} = −18 mA		−0.8	−1.2		−0.8	−1.2	V
C_{IN}	Input Capacitance	V_{CC} = 5V, V_{IN} = 2V, T_A = 25°C, 1 MHz		4.0			4.0		pF
C_O	Output Capacitance	V_{CC} = 5V, V_O = 2V, T_A = 25°C, 1 MHz, Output "OFF"		6.0			6.0		pF
I_{CC}	Power Supply Current	V_{CC} = Max, All Inputs Grounded, All Outputs Open		80	130		80	130	mA
TRI-STATE PARAMETERS									
I_{SC}	Output Short Circuit Current	V_O = 0V, V_{CC} = Max, (Note 4)	−30	−60	−100	−30	−60	−100	mA
I_{HZ}	Output Leakage (TRI-STATE)	V_{CC} = Max, V_O = 0.45 to 2.4V, Chip Disabled			±50			±50	μA
V_{OH}	Output Voltage High, (Note 5)	I_{OH} = −2 mA	2.4	3.2					V
		I_{OH} = −6.5 mA				2.4	3.2		V

ac electrical characteristics (With standard load)

PARAMETER		CONDITIONS	DM54S387/287 5V ±10%; −55°C to +125°C			DM74S387/287 5V ±5%; 0°C to +70°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{AA}	Address Access Time		10	35	60	10	35	50	ns
t_{EA}	Enable Access Time		5	15	30	5	15	25	ns
t_{ER}	Enable Recovery Time		5	15	30	5	15	25	ns

Note 1: Absolute maximum ratings are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

Note 2: These limits do not apply during programming. For the programming ratings, refer to the programming instructions.

Note 3: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

Note 4: During I_{SC} measurement, only one output at a time should be grounded. Permanent damage may otherwise result.

Note 5: To measure V_{OH} or I_{CEX} on an unprogrammed part, apply 10.5V to both A7 and A2 (pin 15 and pin 7).

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DM54S570/DM74S570 open-collector 2048-bit PROM
DM54S571/DM74S571 TRI-STATE® 2048-bit PROM

general description

These Schottky PROM memories are organized in the popular 512 words by 4 bits configuration. A memory enable input is provided to control the output states. When the enable input is in the low state, the outputs present the contents of the selected word.

If the enable input is raised to a high level, it causes all 4 outputs to go to the "OFF" or high impedance state. The memories are available in both open-collector and TRI-STATE versions and are available as ROM's as well as PROM's.

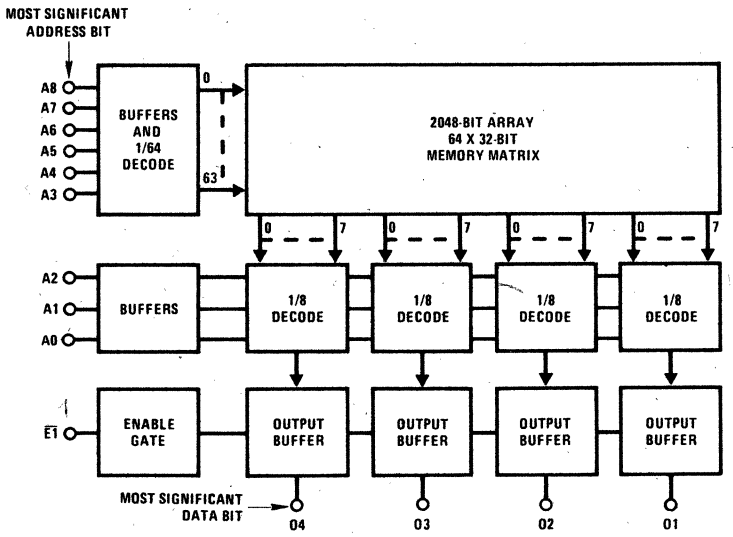
PROM's are shipped from the factory with lows in all locations. A high may be programmed into any selected location by following the programming instructions. Once programmed, it is impossible to go back to a low.

features

- Advanced titanium-tungsten (Ti-W) fuses
- Schottky-clamped for high speed
  Address access—55 ns max
  Enable access—30 ns max
- PNP inputs reduce input loading
- All dc and ac parameters guaranteed over temperature
- Low voltage TRI-SAFE™ programming
- Board level programming
- ROM mates are DM74S270 and DM74S370

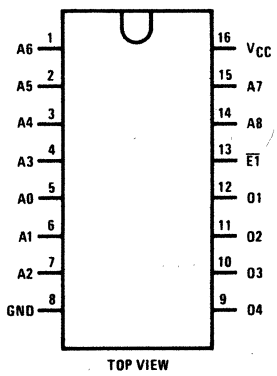
	Military	Commercial	Open-Collector	TRI-STATE	Package
DM74S570		X	X		N, J
DM74S571		X		X	N, J
DM54S570	X		X		J
DM54S571	X			X	J

block diagram



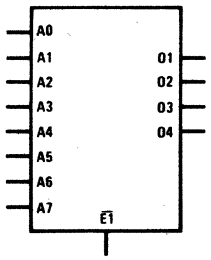
connection diagram

Dual-In-Line Package



TOP VIEW

logic symbol



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absolute maximum ratings (Note 1)

Supply Voltage (Note 2)	−0.5V to +7V
Input Voltage (Note 2)	−1.2V to +5.5V
Output Voltage (Note 2)	−0.5V to +5.5V
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM54S570, DM54S571	4.5	5.5	V
DM74S570, DM74S571	4.75	5.25	V
Ambient Temperature (T_A)			
DM54S570, DM54S571	−55	+125	°C
DM74S570, DM74S571	0	+70	°C
Logical "0" Input Voltage (Low)	0	0.8	V
Logical "1" Input Voltage (High)	2.0	5.5	V

dc electrical characteristics (Note 3)

PARAMETER		CONDITIONS	DM54S570, 54S571			DM74S570, 74S571			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{IL}	Input Load Current, All Inputs	V_{CC} = Max, V_{IN} = 0.45V		−80	−250		−80	−250	μA
I_{IH}	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 2.7V			25			25	μA
I_I	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 5.5V			1.0			1.0	mA
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA		0.35	0.5		0.35	0.5	V
V_{IL}	Low Level Input Voltage				0.80			0.80	V
V_{IH}	High Level Input Voltage		2.0			2.0			V
I_{CEX}	Output Leakage Current (Open-Collector Only) (Note 5)	V_{CC} = Max, V_{CEX} = 2.4V			50			50	μA
		V_{CC} = Max, V_{CEX} = 5.5V			100			100	μA
V_C	Input Clamp Voltage	V_{CC} = Min, I_{IN} = −18 mA		−0.8	−1.2		−0.8	−1.2	V
C_{IN}	Input Capacitance	V_{CC} = 5V, V_{IN} = 2V, T_A = 25°C, 1 MHz		4.0			4.0		pF
C_O	Output Capacitance	V_{CC} = 5V, V_O = 2V, T_A = 25°C, 1 MHz, Output "OFF"		6.0			6.0		pF
I_{CC}	Power Supply Current	V_{CC} = Max, All Inputs Grounded, All Outputs Open		90	130		90	130	mA
TRI-STATE PARAMETERS									
I_{SC}	Output Short Circuit Current (Note 5)	V_O = 0V, V_{CC} = Max, (Note 4)	−30	−60	−100	−30	−60	−100	mA
I_{HZ}	Output Leakage (TRI-STATE)	V_{CC} = Max, V_O = 0.45 to 2.4V, Chip Disabled			±50			±50	μA
V_{OH}	Output Voltage High, (Note 5)	I_{OH} = −2 mA	2.4	3.2					V
		I_{OH} = −6.5 mA				2.4	3.2		V

ac electrical characteristics (With standard load)

PARAMETER		CONDITIONS	DM54S570, 54S571 5V ±10%; −55°C to +125°C			DM74S570, 74S571 5V ±5%; 0°C to +70°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{AA}	Address Access Time			40	65		40	55	ns
t_{EA}	Enable Access Time			20	35		20	30	ns
t_{ER}	Enable Recovery Time			20	35		20	30	ns

Note 1: Absolute maximum ratings are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

Note 2: These limits do not apply during programming. For the programming ratings, refer to the programming instructions.

Note 3: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

Note 4: During I_{SC} measurement, only one output at a time should be grounded. Permanent damage may otherwise result.

Note 5: To measure V_{OH}, I_{CEX} or I_{SC} on an unprogrammed part, apply 10.5V to both A8 and A2 (pin 14 and pin 7).

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Preliminary

DM54S572/DM74S572 open-collector 4096-bit PROM
DM54S573/DM74S573 TRI-STATE® 4096-bit PROM

general description

These Schottky PROM memories are organized in the popular 1024 words by 4 bits configuration. Two memory enable inputs are provided to control the output states. When the enable inputs are in the low state, the outputs present the contents of the selected word.

If either or both of the enable inputs is raised to a high level, it causes all 4 outputs to go to the "OFF" or high impedance state. The memories are available in both open-collector and TRI-STATE® versions.

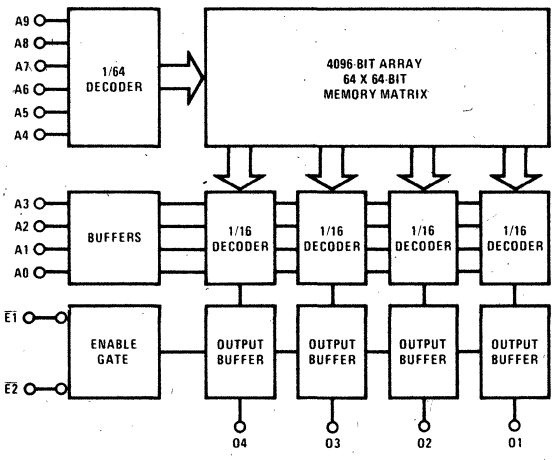
PROM's are shipped from the factory with lows in all locations. A high may be programmed into any selected location by following the programming instructions. Once programmed, it is impossible to go back to a low.

features

- Advanced titanium-tungsten (Ti-W) fuses
- Schottky-clamped for high speed
  Address access—60 ns max
  Enable access—35 ns max
- PNP inputs reduce input loading
- All dc and ac parameters guaranteed over temperature
- Low voltage TRI-SAFE™ programming
- Board level programming
- High density 18-pin package

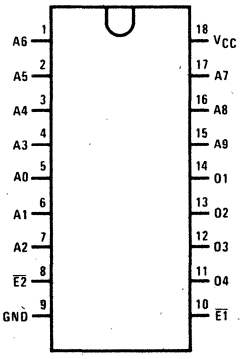
	Military	Commercial	Open-Collector	TRI-STATE	Package
DM74S572		X	X		N, J
DM74S573		X		X	N, J
DM54S572	X		X		J
DM54S573	X			X	J

block diagram



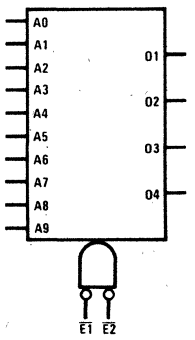
connection diagram

Dual-In-Line Package



TOP VIEW

logic symbol



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absolute maximum ratings (Note 1)

Supply Voltage (Note 2)	0.5V to +7V
Input Voltage (Note 2)	−1.2V to +5.5V
Output Voltage (Note 2)	−0.5V to +5.5V
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM54S572, DM54S573	4.5	5.5	V
DM74S572, DM74S573	4.75	5.25	V
Ambient Temperature (T_A)			
DM54S572, DM54S573	−55	+125	°C
DM74S572, DM74S573	0	+70	°C
Logical "0" Input Voltage (Low)	0	0.8	V
Logical "1" Input Voltage (High)	2.0	5.5	V

dc electrical characteristics (Note 3)

PARAMETER		CONDITIONS	DM54S572, 54S573			DM74S572, 74S573			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{IL}	Input Load Current, All Inputs	V_{CC} = Max, V_{IN} = 0.45V		−80	−250		−80	−250	μA
I_{IH}	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 2.7V			25			25	μA
I_I	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 5.5V			1.0			1.0	mA
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA		0.35	0.5		0.35	0.5	V
V_{IL}	Low Level Input Voltage				0.80			0.80	V
V_{IH}	High Level Input Voltage		2.0			2.0			V
I_{CEX}	Output Leakage Current (Open-Collector Only) (Note 5)	V_{CC} = Max, V_{CEX} = 2.4V			50			50	μA
		V_{CC} = Max, V_{CEX} = 5.5V			100			100	μA
V_C	Input Clamp Voltage	V_{CC} = Min, I_{IN} = −18 mA		−0.8	−1.2		−0.8	−1.2	V
C_{IN}	Input Capacitance	V_{CC} = 5V, V_{IN} = 2V, T_A = 25°C, 1 MHz		4.0			4.0		pF
C_O	Output Capacitance	V_{CC} = 5V, V_O = 2V, T_A = 25°C, 1 MHz, Output "OFF"		6.0			6.0		pF
I_{CC}	Power Supply Current	V_{CC} = Max, All Inputs Grounded, All Outputs Open		125	140		125	140	mA
TRI-STATE PARAMETERS									
I_{SC}	Output Short Circuit Current (Note 5)	V_O = 0V, V_{CC} = Max, (Note 4)	−30	−60	−100	−30	−60	−100	mA
I_{HZ}	Output Leakage (TRI-STATE)	V_{CC} = Max, V_O = 0.45 to 2.4V, Chip Disabled			±50			±50	μA
V_{OH}	Output Voltage High, (Note 5)	I_{OH} = −2 mA	2.4	3.2					V
		I_{OH} = −6.5 mA				2.4	3.2		V

ac electrical characteristics (With standard load)

PARAMETER		CONDITIONS	DM54S572, 54S573 5V ±10%; −55°C to +125°C			DM74S572, 74S573 5V ±5%; 0°C to +70°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{AA}	Address Access Time			40	75		40	60	ns
t_{EA}	Enable Access Time			25	45		25	35	ns
t_{ER}	Enable Recovery Time			25	45		25	35	ns

Note 1: Absolute maximum ratings are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

Note 2: These limits do not apply during programming. For the programming ratings, refer to the programming instructions.

Note 3: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

Note 4: During I_{SC} measurement, only one output at a time should be grounded. Permanent damage may otherwise result.

Note 5: To measure V_{OH}, I_{CEX} or I_{SC} on an unprogrammed part, apply 10.5V to both A7 and A2 (pin 15 and pin 7).

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DM77S295/DM87S295 open-collector 4096-bit PROM
DM77S296/DM87S296 TRI-STATE® 4096-bit PROM

general description

These Schottky memories are organized in the popular 512 words by 8 bits configuration. Four memory enable inputs are provided to control the output states. When E1 and E2 are low and E3 and E4 are high, the output presents the contents of the selected word.

If E1 or E2 are high, or E3 or E4 are low, it causes all 8 outputs to go to the "OFF" or high impedance state. The memories are available in both open-collector and TRI-STATE versions and are available as ROM's as well as PROM's.

PROM's are shipped from the factory with lows in all locations. A high may be programmed into any selected location by following the programming instructions. Once programmed, it is impossible to go back to a low.

features

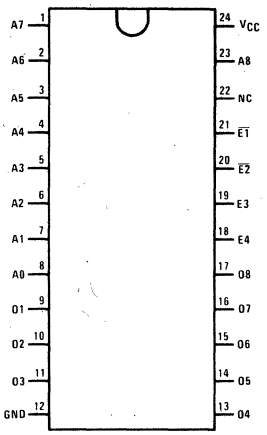
- Advanced titanium-tungsten (Ti-W) fuses
- Schottky-clamped for high speed
  - Address access—65 ns
  - Enable access—35 ns
- PNP inputs reduce input loading
- All dc and ac parameters guaranteed over temperature
- Low voltage TRI-SAFE™ programming
- Board level programming
- ROM mates are DM87S95 and DM87S96

selection guide

	Military	Commercial	Open-Collector	TRI-STATE	Package
DM87S295		X	X		N, J
DM87S296		X		X	N, J
DM77S295	X		X		J
DM77S296	X			X	J

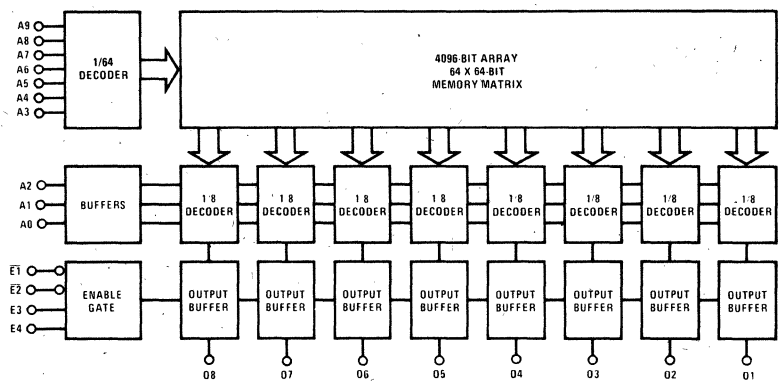
connection diagram

Dual-In-Line Package



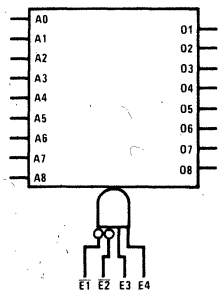
TOP VIEW

block diagram



The device is enabled when: $\overline{E1} \cdot \overline{E2} \cdot E3 \cdot E4$

logic symbol



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absolute maximum ratings (Note 1)

Supply Voltage (Note 2)	−0.5V to +7V
Input Voltage (Note 2)	−1.2V to +5.5V
Output Voltage (Note 2)	−0.5V to +5.5V
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM77S295, DM77S296	4.5	5.5	V
DM87S295, DM87S296	4.75	5.25	V
Ambient Temperature (T_A)			
DM77S295, DM77S296	−55	+125	°C
DM87S295, DM87S296	0	+70	°C
Logical "0" Input Voltage (Low)	0	0.8	V
Logical "1" Input Voltage (High)	2.0	5.5	V

dc electrical characteristics (Note 3)

PARAMETER		CONDITIONS	DM77S295, 296			DM87S295, 296			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{IL}	Input Load Current, All Inputs	V_{CC} = Max, V_{IN} = 0.45V		−80	−250		−80	−250	μA
I_{IH}	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 2.7V			25			25	μA
I_I	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 5.5V			1.0			1.0	mA
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA		0.35	0.5		0.35	0.5	V
V_{IL}	Low Level Input Voltage				0.80			0.80	V
V_{IH}	High Level Input Voltage		2.0			2.0			V
I_{CEX}	Output Leakage Current (Open-Collector Only) (Note 5)	V_{CC} = Max, V_{CEX} = 2.4V			50			50	μA
		V_{CC} = Max, V_{CEX} = 5.5V			100			100	μA
V_C	Input Clamp Voltage	V_{CC} = Min, I_{IN} = −18 mA		−0.8	−1.2		−0.8	−1.2	V
C_{IN}	Input Capacitance	V_{CC} = 5V, V_{IN} = 2V, T_A = 25°C, 1 MHz		4.0			4.0		pF
C_O	Output Capacitance	V_{CC} = 5V, V_O = 2V, T_A = 25°C, 1 MHz, Output "OFF"		6.0			6.0		pF
I_{CC}	Power Supply Current	V_{CC} = Max, All Inputs Grounded, All Outputs Open		115	170		115	170	mA
TRI-STATE PARAMETERS									
I_{SC}	Output Short Circuit Current (Note 5)	V_O = 0V, V_{CC} = Max, (Note 4)	−30	−60	−100	−30	−60	−100	mA
I_{HZ}	Output Leakage (TRI-STATE)	V_{CC} = Max, V_O = 0.45 to 2.4V, Chip Disabled			±50			±50	μA
V_{OH}	Output Voltage High, (Note 5)	I_{OH} = −2 mA	2.4	3.2					V
		I_{OH} = −6.5 mA				2.4	3.2		V

ac electrical characteristics (With standard load)

PARAMETER		CONDITIONS	DM77S295, 296 5V ±10%; −55°C to +125°C			DM87S295, 296 5V ±5%; 0°C to +70°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{AA}	Address Access Time			40	75		40	65	ns
t_{EA}	Enable Access Time			20	40		20	35	ns
t_{ER}	Enable Recovery Time			20	40		20	35	ns

Note 1: Absolute maximum ratings are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

Note 2: These limits do not apply during programming. For the programming ratings, refer to the programming instructions.

Note 3: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

Note 4: During I_{SC} measurement, only one output at a time should be grounded. Permanent damage may otherwise result.

Note 5: To measure V_{OH}, I_{CEX} or I_{SC} on an unprogrammed part, apply 10.5V to both A7 and A2 (pin 1 and pin 6).

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Preliminary

DM77S229/DM87S229 open-collector 8196-bit PROM
DM77S228/DM87S228 TRI-STATE® 8196-bit PROM

general description

These Schottky PROM memories are organized in the popular 1024 words by 8 bits configuration. Four memory enable inputs are provided to control the output states. When E1 and E2 are low and E3 and E4 are high, the output presents the contents of the selected word.

If E1 or E2 are high, or E3 or E4 are low, it causes all 8 outputs to go to the "OFF" or high impedance state. The memories are available in both open-collector and TRI-STATE versions and are available as ROM's as well as PROM's.

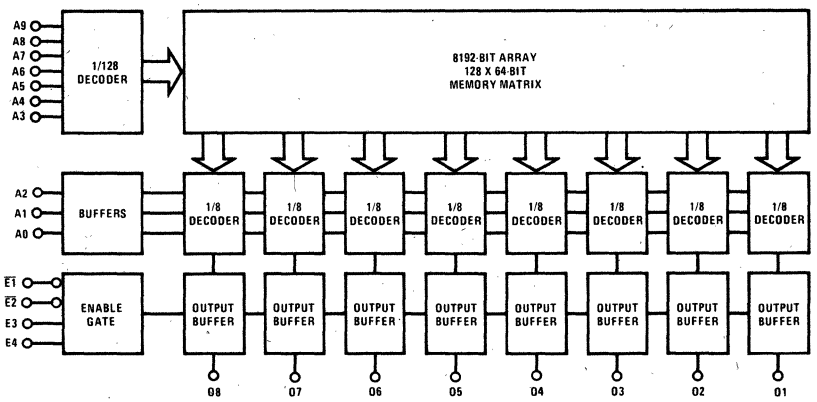
PROM's are shipped from the factory with lows in all locations. A high may be programmed into any selected location by following the programming instructions. Once programmed, it is impossible to go back to a low.

features

- Advanced titanium-tungsten (Ti-W) fuses
- Schottky-clamped for high speed
  Address access—70 ns max
  Enable access—45 ns max
- PNP inputs reduce input loading
- All dc and ac parameters guaranteed over temperature
- Low voltage TRI-SAFE™ programming
- Board level programming
- ROM mates are DM85S29 and DM85S28

	Military	Commercial	Open-Collector	TRI-STATE	Package
DM87S229		X	X		N, J
DM87S228		X		X	N, J
DM77S229	X		X		J
DM77S228	X			X	J

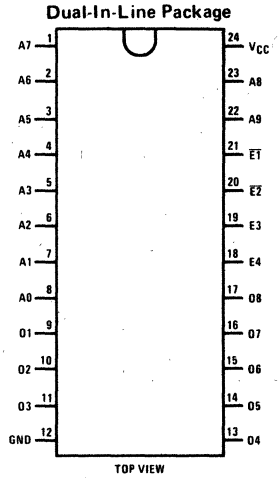
block diagram



The device is enabled when: $\overline{E1} \cdot \overline{E2} \cdot E3 \cdot E4$

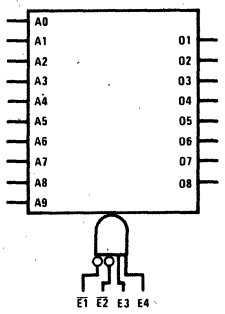
connection diagram

Dual-In-Line Package



TOP VIEW

logic symbol



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absolute maximum ratings (Note 1)

Supply Voltage (Note 2)	0.5V to +7V
Input Voltage (Note 2)	−1.2V to +5.5V
Output Voltage (Note 2)	−0.5V to +5.5V
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM77S229, DM77S228	4.5	5.5	V
DM87S229, DM87S228	4.75	5.25	V
Ambient Temperature (T_A)			
DM77S229, DM77S228	−55	+125	°C
DM87S229, DM87S228	0	+70	°C
Logical "0" Input Voltage (Low)	0	0.8	V
Logical "1" Input Voltage (High)	2.0	5.5	V

dc electrical characteristics (Note 3)

PARAMETER		CONDITIONS	DM77S229, 77S228			DM87S229, 87S228			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{IL}	Input Load Current, All Inputs	V_{CC} = Max, V_{IN} = 0.45V		−80	−250		−80	−250	μA
I_{IH}	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 2.7V			25			25	μA
I_I	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 5.5V			1.0			1.0	mA
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA		0.35	0.5		0.35	0.5	V
V_{IL}	Low Level Input Voltage				0.80			0.80	V
V_{IH}	High Level Input Voltage		2.0			2.0			V
I_{CEX}	Output Leakage Current (Open-Collector Only) (Note 5)	V_{CC} = Max, V_{CEX} = 2.4V			50			50	μA
		V_{CC} = Max, V_{CEX} = 5.5V			100			100	μA
V_C	Input Clamp Voltage	V_{CC} = Min, I_{IN} = −18 mA		−0.8	−1.2		−0.8	−1.2	V
C_{IN}	Input Capacitance	V_{CC} = 5V, V_{IN} = 2V, T_A = 25°C, 1 MHz		4.0			4.0		pF
C_O	Output Capacitance	V_{CC} = 5V, V_O = 2V, T_A = 25°C, 1 MHz, Output "OFF"		6.0			6.0		pF
I_{CC}	Power Supply Current	V_{CC} = Max, All Inputs Grounded, All Outputs Open		135	170		135	170	mA
TRI-STATE PARAMETERS									
I_{SC}	Output Short Circuit Current (Note 5)	V_O = 0V, V_{CC} = Max, (Note 4)	−30	−60	−100	−30	−60	−100	mA
I_{HZ}	Output Leakage (TRI-STATE)	V_{CC} = Max, V_O = 0.45 to 2.4V, Chip Disabled			±50			±50	μA
V_{OH}	Output Voltage High, (Note 5)	I_{OH} = −2 mA	2.4	3.2					V
		I_{OH} = −6.5 mA				2.4	3.2		V

ac electrical characteristics (With standard load)

PARAMETER		CONDITIONS	DM77S229, 77S228 5V ±10%; −55°C to +125°C			DM87S229, 87S228 5V ±5%; 0°C to +70°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{AA}	Address Access Time			57	90		57	70	ns
t_{EA}	Enable Access Time			31	60		31	45	ns
t_{ER}	Enable Recovery Time			31	60		31	45	ns

Note 1: Absolute maximum ratings are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

Note 2: These limits do not apply during programming. For the programming ratings, refer to the programming instructions.

Note 3: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

Note 4: During I_{SC} measurement, only one output at a time should be grounded. Permanent damage may otherwise result.

Note 5: To measure V_{OH}, I_{CEX} or I_{SC} on an unprogrammed part, apply 10.5V to both A7 and A2 (pin 15 and pin 7).

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Preliminary

DM54S470/DM74S470 open-collector 2048-bit PROM
DM54S471/DM74S471 TRI-STATE® 2048-bit PROM

general description

These Schottky PROM memories are organized in the popular 256 words by 8 bits configuration. Two memory enable inputs are provided to control the output states. When the enable inputs are in the low state, the outputs present the contents of the selected word.

If either or both of the enable inputs is raised to a high level, it causes all 8 outputs to go to the "OFF" or high impedance state. The memories are available in both open-collector and TRI-STATE versions and are available as ROM's as well as PROM's.

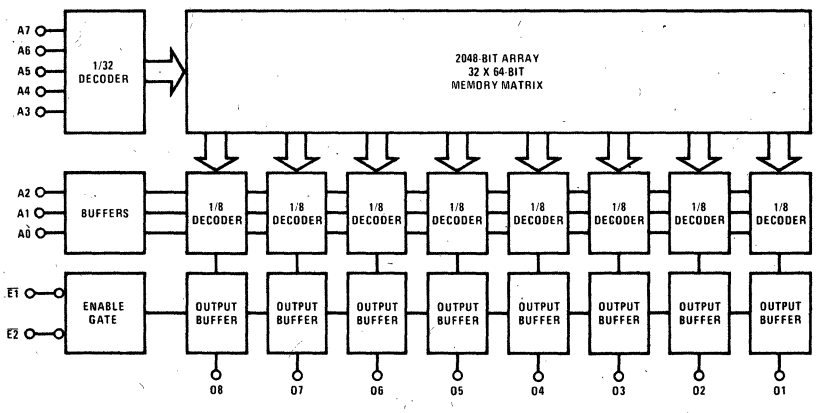
PROM's are shipped from the factory with lows in all locations. A high may be programmed into any selected location by following the programming instructions. Once programmed, it is impossible to go back to a low.

features

- Advanced titanium-tungsten (Ti-W) fuses
- Schottky-clamped for high speed
  Address access—60 ns max
  Enable access—35 ns max
- PNP inputs reduce input loading
- All dc and ac parameters guaranteed over temperature
- Low voltage TRI-SAFE™ programming
- High density 20-pin package
- ROM mates are DM74S271 and DM74S371

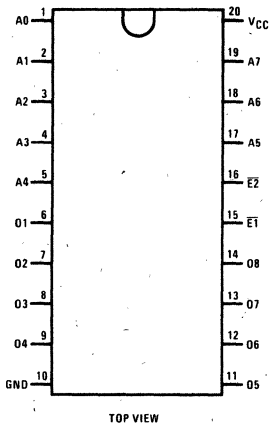
	Military	Commercial	Open-Collector	TRI-STATE	Package
DM74S470		X	X		N, J
DM74S471		X		X	N, J
DM54S470	X		X		J
DM54S471	X			X	J

block diagram



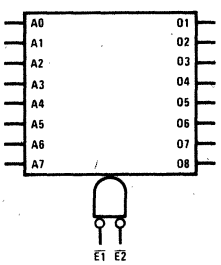
connection diagram

Dual-In-Line Package



TOP VIEW

logic symbol



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absolute maximum ratings (Note 1)

Supply Voltage (Note 2)	-0.5V to +7V
Input Voltage (Note 2)	−1.2V to +5.5V
Output Voltage (Note 2)	−0.5V to +5.5V
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM54S470, DM54S471	4.5	5.5	V
DM74S470, DM74S471	4.75	5.25	V
Ambient Temperature (T_A)			
DM54S470, DM54S471	−55	+125	°C
DM74S470, DM74S471	0	+70	°C
Logical "0" Input Voltage (Low)	0	0.8	V
Logical "1" Input Voltage (High)	2.0	5.5	V

dc electrical characteristics (Note 3)

PARAMETER		CONDITIONS	DM54S470, DM54S471			DM74S470, DM74S471			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{IL}	Input Load Current, All Inputs	V_{CC} = Max, V_{IN} = 0.45V		−80	−250		−80	−250	μA
I_{IH}	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 2.7V			25			25	μA
I_I	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 5.5V			1.0			1.0	mA
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA		0.35	0.5		0.35	0.5	V
V_{IL}	Low Level Input Voltage				0.80			0.80	V
V_{IH}	High Level Input Voltage		2.0			2.0			V
I_{CEX}	Output Leakage Current (Open-Collector Only) (Note 5)	V_{CC} = Max, V_{CEX} = 2.4V			50			50	μA
		V_{CC} = Max, V_{CEX} = 5.5V			100			100	μA
V_C	Input Clamp Voltage	V_{CC} = Min, I_{IN} = −18 mA		−0.8	−1.2		−0.8	−1.2	V
C_{IN}	Input Capacitance	V_{CC} = 5V, V_{IN} = 2V, T_A = 25°C, 1 MHz		4.0			4.0		pF
C_O	Output Capacitance	V_{CC} = 5V, V_O = 2V, T_A = 25°C, 1 MHz, Output "OFF"		6.0			6.0		pF
I_{CC}	Power Supply Current	V_{CC} = Max, All Inputs Grounded, All Outputs Open		120	150		120	150	mA
TRI-STATE PARAMETERS									
I_{SC}	Output Short Circuit Current (Note 5)	V_O = 0V, V_{CC} = Max, (Note 4)	−30	−60	−100	−30	−60	−100	mA
I_{HZ}	Output Leakage (TRI-STATE)	V_{CC} = Max, V_O = 0.45 to 2.4V, Chip Disabled			±50			±50	μA
V_{OH}	Output Voltage High, (Note 5)	I_{OH} = −2 mA	2.4	3.2					V
		I_{OH} = −6.5 mA				2.4	3.2		V

ac electrical characteristics (With standard load)

PARAMETER		CONDITIONS	DM54S470, DM54S471 5V ±10%; −55°C to +125°C			DM74S470, DM74S471 5V ±5%; 0°C to +70°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{AA}	Address Access Time			40	75		40	60	ns
t_{EA}	Enable Access Time			20	40		20	30	ns
t_{ER}	Enable Recovery Time			20	40		20	30	ns

Note 1: Absolute maximum ratings are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

Note 2: These limits do not apply during programming. For the programming ratings, refer to the programming instructions.

Note 3: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

Note 4: During I_{SC} measurement, only one output at a time should be grounded. Permanent damage may otherwise result.

Note 5: To measure V_{OH}, I_{CEX} or I_{SC} on an unprogrammed part, apply 10.5V to both A7 and A2 (pin 15 and pin 7).

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Preliminary

DM77S221/DM87S221 open-collector 2048-bit PROM with latches
DM77S222/DM87S222 TRI-STATE® 2048-bit PROM with latches

general description

These Schottky PROM memories are organized in the popular 256 words by 8 bits configuration. A memory enable input is provided to control the output states. When the enable input is in the low state, the outputs present the contents of the selected word. An output latch control is provided. If the latch control pin is high, the data falls through to the output enable gate. If the latch control pin is low, the data is latched and the addresses may be changed without affecting the output data.

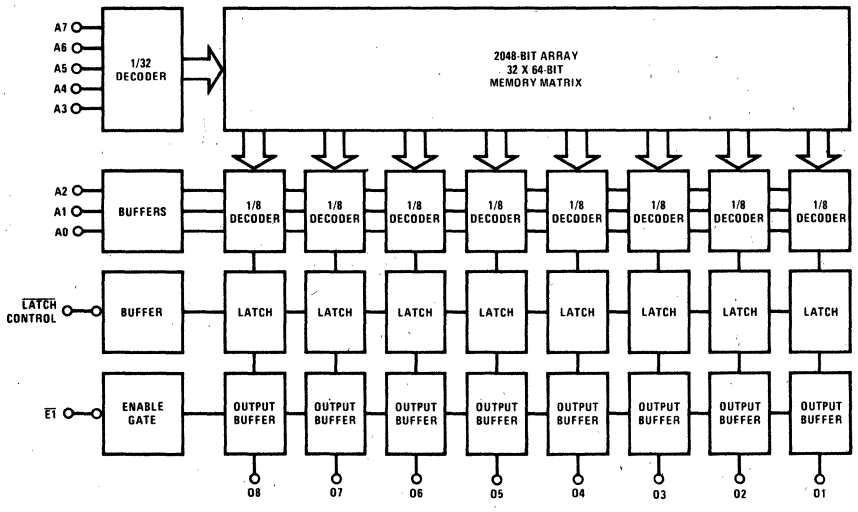
PROM's are shipped from the factory with lows in all locations. A high may be programmed into any selected location by following the programming instructions. Once programmed, it is impossible to go back to a low.

features

- Advanced titanium-tungsten (Ti-W) fuses
- Schottky-clamped for high speed
  Address access—60 ns max
  Enable access— 30 ns max
- PNP inputs reduce input loading
- All dc and ac parameters guaranteed over temperature
- Low voltage TRI-SAFE™ programming
- Open-collector or TRI-STATE® outputs
- Board level programming
- High density 20-pin package
- ROM mates are DM87S201 and DM87S202

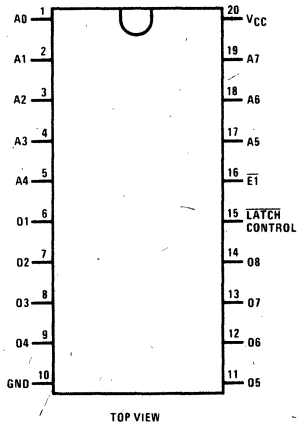
	Military	Commercial	Open-Collector	TRI-STATE	Package
DM87S221		X	X		N, J
DM87S222		X		X	N, J
DM77S221	X		X		J
DM77S222	X			X	J

block diagram



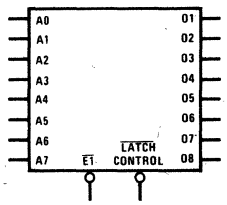
connection diagram

Dual-In-Line Package



TOP VIEW

logic symbol



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absolute maximum ratings (Note 1)

Supply Voltage (Note 2)	−0.5V to +7V
Input Voltage (Note 2)	−1.2V to +5.5V
Output Voltage (Note 2)	−0.5V to +5.5V
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM77S221, DM77S222	4.5	5.5	V
DM87S221, DM87S222	4.75	5.25	V
Ambient Temperature (T_A)			
DM77S221, DM77S222	−55	+125	°C
DM87S221, DM87S222	0	+70	°C
Logical "0" Input Voltage (Low)	0	0.8	V
Logical "1" Input Voltage (High)	2.0	5.5	V

dc electrical characteristics (Note 3)

PARAMETER		CONDITIONS	DM77S221, 77S222			DM87S221, 87S222			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{IL}	Input Load Current, All Inputs	V_{CC} = Max, V_{IN} = 0.45V		−80	−250		−80	−250	μA
I_{IH}	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 2.7V			25			25	μA
I_I	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 5.5V			1.0			1.0	mA
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA		0.35	0.5		0.35	0.5	V
V_{IL}	Low Level Input Voltage				0.80			0.80	V
V_{IH}	High Level Input Voltage		2.0			2.0			V
I_{CEX}	Output Leakage Current (Open-Collector Only) (Note 5)	V_{CC} = Max, V_{CEX} = 2.4V			50			50	μA
		V_{CC} = Max, V_{CEX} = 5.5V			100			100	μA
V_C	Input Clamp Voltage	V_{CC} = Min, I_{IN} = −18 mA		−0.8	−1.2		−0.8	−1.2	V
C_{IN}	Input Capacitance	V_{CC} = 5V, V_{IN} = 2V, T_A = 25°C, 1 MHz		4.0			4.0		pF
C_O	Output Capacitance	V_{CC} = 5V, V_O = 2V, T_A = 25°C, 1 MHz, Output "OFF"		6.0			6.0		pF
I_{CC}	Power Supply Current	V_{CC} = Max, All Inputs Grounded, All Outputs Open		120	150		120	150	mA
TRI-STATE PARAMETERS									
I_{SC}	Output Short Circuit Current (Note 5)	V_O = 0V, V_{CC} = Max, (Note 4)	−30	−60	−100	−30	−60	−100	mA
I_{HZ}	Output Leakage (TRI-STATE)	V_{CC} = Max, V_O = 0.45 to 2.4V, Chip Disabled			±50			±50	μA
V_{OH}	Output Voltage High, (Note 5)	I_{OH} = −2 mA	2.4	3.2					V
		I_{OH} = −6.5 mA				2.4	3.2		V

ac electrical characteristics (With standard load)

PARAMETER		CONDITIONS	DM77S221, 77S222 5V ±10%; −55°C to +125°C			DM87S221, 87S222 5V ±5%; 0°C to +70°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{AA}	Address Access Time			40	75		40	60	ns
t_{EA}	Enable Access Time			20	40		20	30	ns
t_{ER}	Enable Recovery Time			20	40		20	30	ns
t_{LO}	Latch To Output			15	30		15	20	ns

Note 1: Absolute maximum ratings are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

Note 2: These limits do not apply during programming. For the programming ratings, refer to the programming instructions.

Note 3: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

Note 4: During I_{SC} measurement, only one output at a time should be grounded. Permanent damage may otherwise result.

Note 5: To measure V_{OH}, I_{CEX} or I_{SC} on an unprogrammed part, apply 10.5V to both A7 and A2 (pin 15 and pin 7).

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Preliminary

DM54S473/DM74S473 open-collector 4096-bit PROM
DM54S472/DM74S472 TRI-STATE® 4096-bit PROM

general description

These Schottky PROM memories are organized in the popular 512 words by 8 bits configuration. A memory enable input is provided to control the output states. When the enable input is in the low state, the outputs present the contents of the selected word.

If the enable input is raised to a high level, it causes all 8 outputs to go to the "OFF" or high impedance state. The memories are available in both open-collector and TRI-STATE versions.

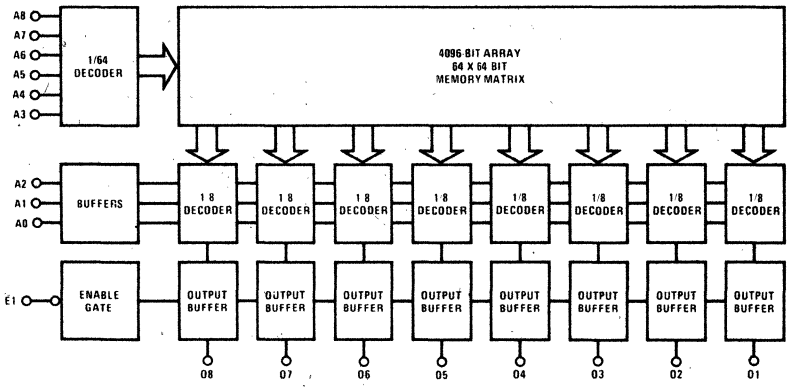
PROM's are shipped from the factory with lows in all locations. A high may be programmed into any selected location by following the programming instructions. Once programmed, it is impossible to go back to a low.

features

- Advanced titanium-tungsten (Ti-W) fuses
- Schottky-clamped for high speed
  Address access—65 ns max
  Enable access—40 ns max
- PNP inputs reduce input loading
- All dc and ac parameters guaranteed over temperature
- Low voltage TRI-SAFE™ programming
- Board level programming
- High density 20-pin package

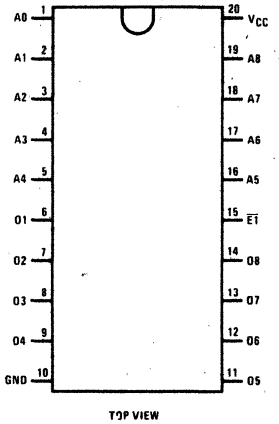
	Military	Commercial	Open-Collector	TRI-STATE	Package
DM74S473		X	X		N, J
DM74S472		X		X	N, J
DM54S473	X		X		J
DM54S472	X			X	J

block diagram



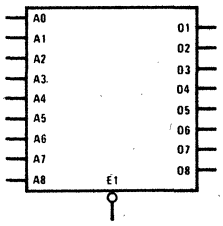
connection diagram

Dual-In-Line Package



TOP VIEW

logic symbol



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absolute maximum ratings (Note 1)

Supply Voltage (Note 2)	−0.5V to +7V
Input Voltage (Note 2)	−1.2V to +5.5V
Output Voltage (Note 2)	−0.5V to +5.5V
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM54S473, DM54S472	4.5	5.5	V
DM74S473, DM74S472	4.75	5.25	V
Ambient Temperature (T_A)			
DM54S473, DM54S472	−55	+125	°C
DM74S473, DM74S472	0	+70	°C
Logical "0" Input Voltage (Low)	0	0.8	V
Logical "1" Input Voltage (High)	2.0	5.5	V

dc electrical characteristics (Note 3)

PARAMETER		CONDITIONS	DM54S473, 54S472			DM74S473, 74S472			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{IL}	Input Load Current, All Inputs	V_{CC} = Max, V_{IN} = 0.45V		−80	−250		−80	−250	μA
I_{IH}	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 2.7V			25			25	μA
I_I	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 5.5V			1.0			1.0	mA
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA		0.35	0.5		0.35	0.5	V
V_{IL}	Low Level Input Voltage				0.80			0.80	V
V_{IH}	High Level Input Voltage		2.0			2.0			V
I_{CEX}	Output Leakage Current (Open-Collector Only) (Note 5)	V_{CC} = Max, V_{CEX} = 2.4V			50			50	μA
		V_{CC} = Max, V_{CEX} = 5.5V			100			100	μA
V_C	Input Clamp Voltage	V_{CC} = Min, I_{IN} = −18 mA		−0.8	−1.2		−0.8	−1.2	V
C_{IN}	Input Capacitance	V_{CC} = 5V, V_{IN} = 2V, T_A = 25°C, 1 MHz		4.0			4.0		pF
C_O	Output Capacitance	V_{CC} = 5V, V_O = 2V, T_A = 25°C, 1 MHz, Output "OFF"		6.0			6.0		pF
I_{CC}	Power Supply Current	V_{CC} = Max, All Inputs Grounded, All Outputs Open		135	165		135	165	mA
TRI-STATE PARAMETERS									
I_{SC}	Output Short Circuit Current (Note 5)	V_O = 0V, V_{CC} = Max, (Note 4)	−30	−60	−100	−30	−60	−100	mA
I_{HZ}	Output Leakage (TRI-STATE)	V_{CC} = Max, V_O = 0.45 to 2.4V, Chip Disabled			±50			±50	μA
V_{OH}	Output Voltage High, (Note 5)	I_{OH} = −2 mA	2.4	3.2					V
		I_{OH} = −6.5 mA				2.4	3.2		V

ac electrical characteristics (With standard load)

PARAMETER		CONDITIONS	DM54S473, 54S472 5V ±10%; −55°C to +125°C			DM74S473, 74S472 5V ±5%; 0°C to +70°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{AA}	Address Access Time			45	80		45	65	ns
t_{EA}	Enable Access Time			28	55		28	40	ns
t_{ER}	Enable Recovery Time			28	55		28	40	ns

Note 1: Absolute maximum ratings are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

Note 2: These limits do not apply during programming. For the programming ratings, refer to the programming instructions.

Note 3: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

Note 4: During I_{SC} measurement, only one output at a time should be grounded. Permanent damage may otherwise result.

Note 5: To measure V_{OH}, I_{CEX} or I_{SC} on an unprogrammed part, apply 10.5V to both A7 and A2 (pin 15 and pin 7).

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DM8678 bipolar character generator

general description

The DM8678 is a 64-character bipolar character generator with serial output, and packaged in a standard 16-pin DIP designed primarily for the CRT display marketplace. The DM8678 incorporates several CRT system level functions, as well as a 7 x 9 or 5 x 7 row scan character font. The DM8678 performs the system functions of parallel to serial shifting, character address latching, character spacing, and character line spacing which are normally done with extra packages.

Shifted characters can be generated by the on-chip subtractor.

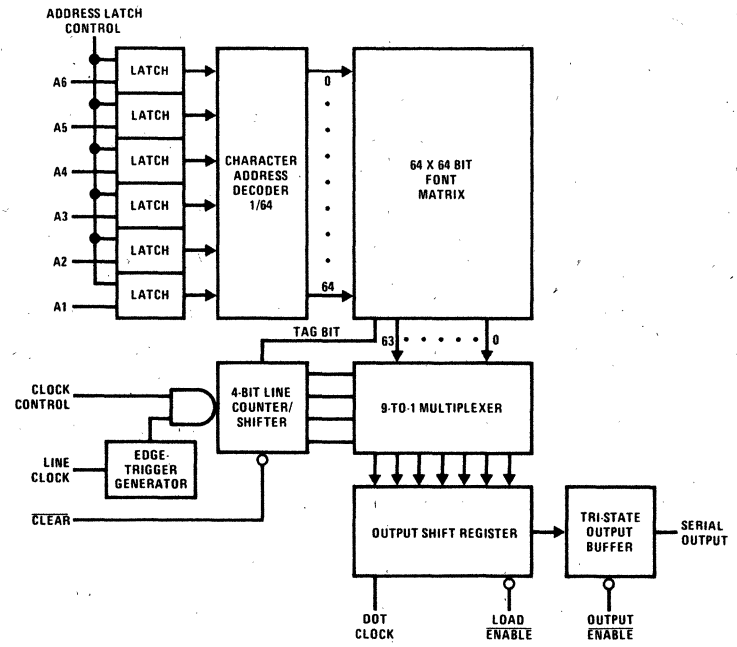
The $\overline{\text{clear}}$ input and the load $\overline{\text{enable}}$ input are active low. load $\overline{\text{enable}}$ is synchronous with the dot clock. Both the line clock and the dot clock are positive edge-triggered. When the address latch control signal is high, the character addresses "Fall Through" the latch. And when the address latch control signal goes low, the character addresses are latched.

features

- 64-character—row scan
- 5 x 7 or 7 x 9 font
- Shifted lower case descending characters
- Serial output
- 16-pin package
- 20 MHz clock rate
- On-chip input latches
- On-chip shift register
- On-chip dot blanking
- On-chip row blanking
- TRI-STATE® output

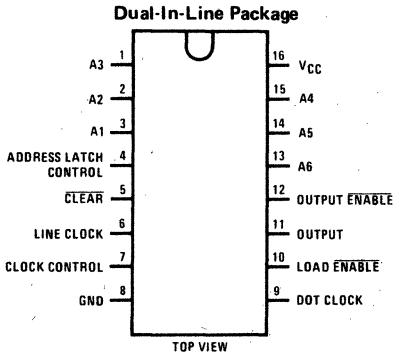
	ROW SCAN	7 x 9	5 x 7	FONT	PACKAGE
DM8678BWF/	X	X		Upper Case Block Letters	N, J
DM8678CAE/	X	X		Shifted Lower Case Block	N, J
DM8678CAB/	X		X	Upper Case Block Letters	N, J
DM8678CAH/	X		X	Shifted Lower Case Block	N, J
DM8678CAD/	X	X		Kata Kana	N, J
DM8678BTK/	X	X		Upper Case Script Letters	N, J
DM8678CAS/	X	X		IBM 3741 Selectric	N, J

block diagram

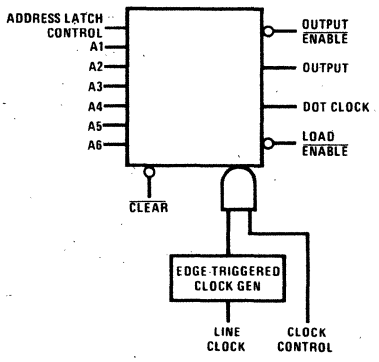


connection diagram

Dual-In-Line Package



logic symbol



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absolute maximum ratings (Note 1)

Supply Voltage	−0.5V to +7V
Input Voltage	−1.2V to +5.5V
Output Voltage	−0.5V to +5.5V
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})	4.75	5.25	V
Ambient Temperature (T_A)	0	+70	°C
Logical "0" Input Voltage (Low)	0	0.8	V
Logical "1" Input Voltage (High)	2.0	5.5	V

dc electrical characteristics (Note 2)

	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
I_{IL}	Input Load Current, All Inputs	V_{CC} = Max, V_{IN} = 0.45V		−0.8	−1.6	mA
I_{IH}	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 2.4V			40	μA
I_I	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 5.5V			1	mA
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA		0.35	0.45	V
V_{IL}	Low Level Input Voltage	V_{CC} = Min			0.80	V
V_{IH}	High Level Input Voltage	V_{CC} = Min	2.0			V
V_C	Input Clamp Voltage	V_{CC} = Min, I_{IN} = −12 mA		−0.8	−1.5	V
C_{IN}	Input Capacitance	V_{CC} = 5V, V_{IN} = 2V, T_A = 25°C, 1 MHz		4.0		pF
C_O	Output Capacitance	V_{CC} = 5V, V_O = 2V, T_A = 25°C, 1 MHz, Output "OFF"		6.0		pF
I_{CC}	Power Supply Current	V_{CC} = Max, All Inputs Grounded, All Outputs Open		115	145	mA
	TRI-STATE PARAMETERS					
I_{SC}	Output Short-Circuit Current	V_O = 0V, V_{CC} = Max	−15		−50	mA
I_{HZ}	Output Leakage	V_{CC} = Max, V_O = 0.45 to 2.4V, Chip Disabled			±40	μA
V_{OH}	Output Voltage High	I_{OH} = −2 mA	2.4	3.2		V

ac electrical characteristics (With standard load) (Note 2)

	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
	Access Time					
T_{DO}	Dot Clock to Output			35	50	ns
T_{EA}	Output Enable			20	40	ns
T_{ER}	Output Disable			20	40	ns
	Set-Up Time					
T_{S1}	Load to Dot Clock		40	25		ns
T_{S2}	Address to Load		350	200		ns
T_{S3}	Clear to Load	See Switching Time Waveforms	350			ns
T_{S4}	Control to Line Clock		40			ns
T_{S5}	Line Clock to Load		950			ns
T_{S6}	Address to Address Latch		40			ns
	Hold Time					
T_{H1}	Load from Dot Clock		0			ns
T_{H2}	Address from Load		0			ns
T_{H3}	Control from Line Clock		100			ns
T_{H4}	Address from Address Latch		40			ns

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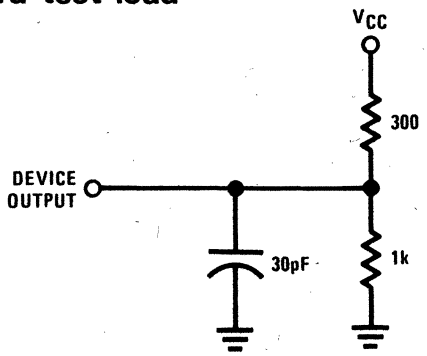
ac electrical characteristics (Continued) (With standard load) (Note 2)

	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
	Minimum Pulse Width					
T_{W1}	Line Clock		40			ns
T_{W2}	Clear		40			ns
T_{W3}	Dot Clock	See Switching Time Waveforms	30			ns
T_{W4}	Load		60			ns
T_{W5}	Address Latch		40			ns
f_{MAX}	Maximum Clock Frequency		16	20		MHz

Note 1: Absolute maximum ratings are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

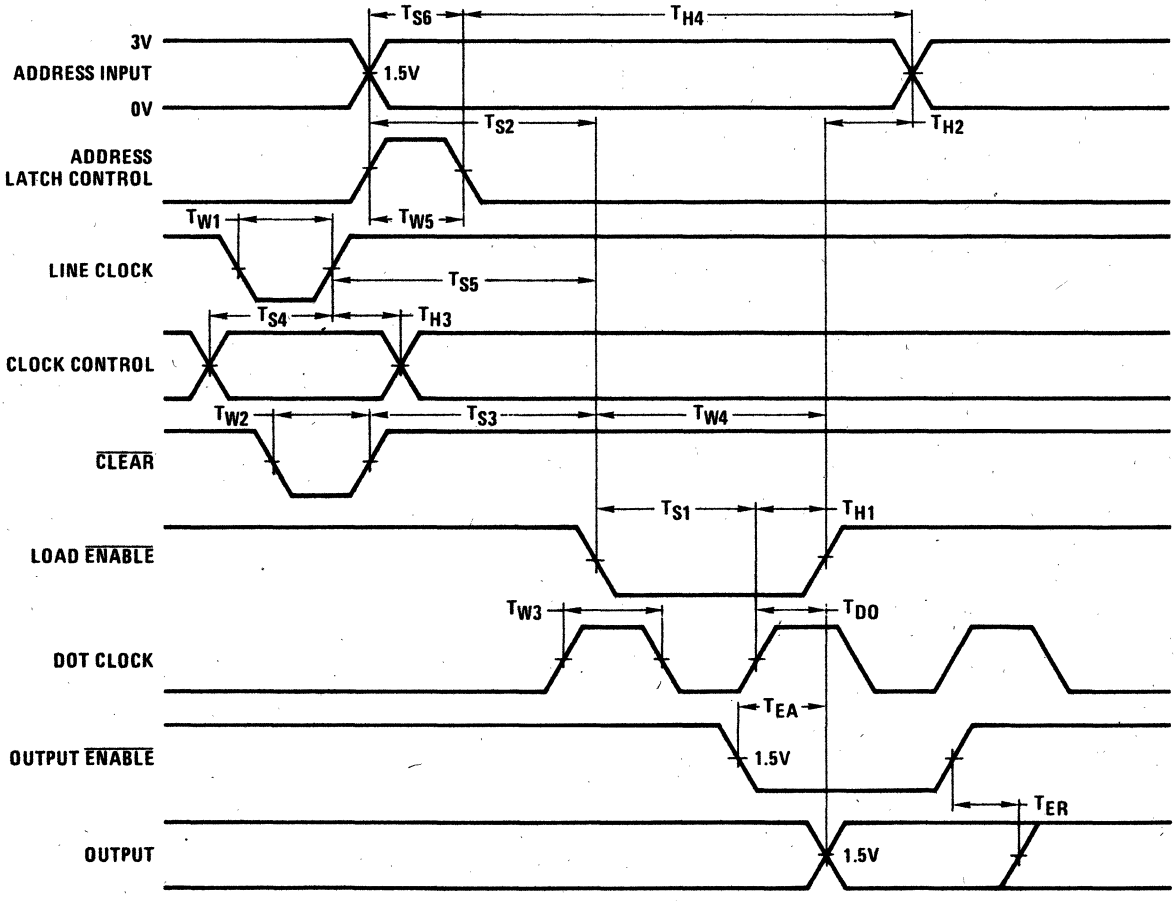
Note 2: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

standard test load



- Input waveforms are supplied by a pulse generator having the following characteristics: PRR = 1 MHz, Z_{OUT} = 50 Ω, $t_r < 2.5$ ns and $t_f < 2.5$ ns (between 1.0V and 2.0V).
- T_{DO} is measured with output enable at a steady low level.

switching time waveforms



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truth tables

a) Address Latch

ADDRESS LATCH CONTROL	FUNCTION PERFORMED
0	Latched
1	Fall Through

b) Output

$\overline{\text{OUTPUT ENABLE}}$	STATE OF THE OUTPUT
1	Output Hi-Z
0	Data Out

c) 4-Bit Line Counter

CLOCK CONTROL	LINE CLOCK	$\overline{\text{CLEAR}}$	LINE COUNTER
H	⌐	H	Increment line counter
X	X	L	Asynchronous clear resets counter
L	X	H	Clock inhibited
H	¬	H	No change on high-to-low clock edge

X = Don't care

definitions

A1–A6: Character address. A 6-bit code which selects 1 of the 64 characters in the font.

$\overline{\text{Clear}}$: Active low clear for mod 16 row counter, (can be used to truncate mod 16 counter).

Line Clock: Clock that advances the line counter. Advances counter on the low-to-high transition.

Clock Control: Enables line clock when high and disables line clock when low.

Load $\overline{\text{Enable}}$: Active low load command which routes data from the character ROM to the "D" inputs of the 7-bit shift register.

Dot Clock: A low-to-high transition of the dot clock loads the shift register if load $\overline{\text{enable}}$ is low or shifts data if load $\overline{\text{enable}}$ is high.

Output $\overline{\text{Enable}}$: An active low output enable. When high the output is in the Hi-Z state.

Output: A TTL TRI-STATE output buffer.

functional description

To select a character, a 6-bit binary word must be present at the address inputs A1–A6 when the address latch control is high. This address can be latched by bringing the address latch control signal low after a 40 ns set-up time. When the $\overline{\text{clear}}$ input receives a low pulse, the counter is reset to zero. The shift register can be loaded (t_{ASL} ns) after the character is addressed. Data, representing one horizontal line of the addressed character, is available at the output when the load $\overline{\text{enable}}$ input is brought low. As shown in *Figure 1*, valid data arrives serially at the output. Dot clock pulses beyond that required to shift out one line of the character will add lows to the end of character. This provides a horizontal spacing between characters.

Figure 2 shows how the counter sequences through the rows of addressed lines with the application of clock pulses at the line clock input. Any additional line clocks beyond that required to display the character will put a vertical space between characters. This spacing can be truncated by bringing the $\overline{\text{clear}}$ input low. Detailed system application infomation is contained in application note AN-167 available from National.

A two character display example is shown in *Figure 3* and a typical system timing waveform is shown in *Figure 4.*

A chip select input is provided for expansion of the character font. The various standard fonts are shown in *Figures 5, 6, 7, 8, 9 and 10.*

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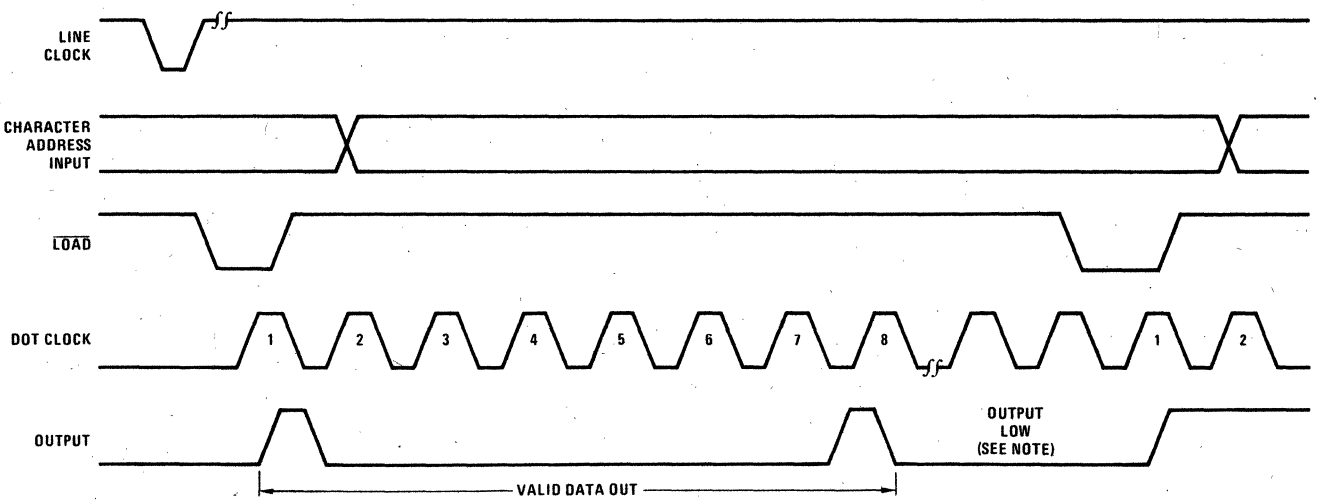
functional description (Continued)

Character Cycle – ROM data corresponding to one line of characters is loaded into the shift register t_{ASL} after the ROM is addressed. When load $\overline{\text{enable}}$ goes low, ROM data is allowed to be present at the D input of the shift register via the MUX. The first bit of the ROM data is transferred to the output at the next low-to-high transition of the dot clock. After load $\overline{\text{enable}}$ goes back high, the second to seventh clock pulses shift out the rest of the selected row of the addressed character. Additional clock pulses will shift out low data used for spacing.

Line Cycle – The line counter is a mod 16 counter. A low-to-high transition of the line clock advances the line counter to the next count. If, for any reason, the counts need to be truncated, a low signal at the $\overline{\text{clear}}$ input resets the counter to zero. The clock control may be used as a line clock disable. A high signal at the line clock control terminal enables the counter and a low signal disables the line clock.



Note. Output goes and stays low following the leading edge of the eighth Dot-Clock pulse until load $\overline{\text{enable}}$ is enabled again and new parallel data is loaded into the shift register.

FIGURE 1. Character Cycle

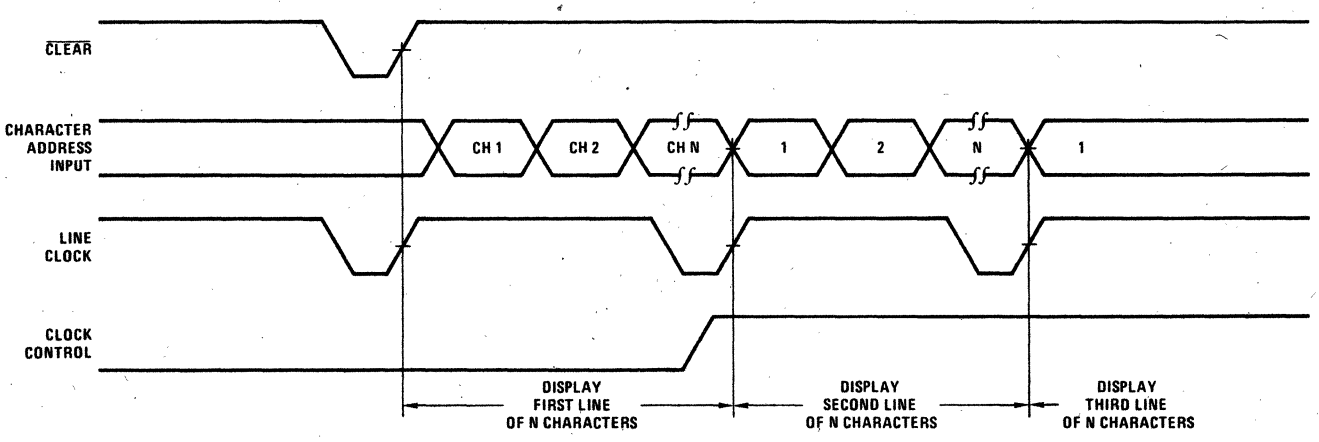


FIGURE 2. Line Cycle

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DM54S270/DM74S270 open-collector 2048-bit ROM
DM54S370/DM74S370 TRI-STATE® 2048-bit ROM

general description

These Schottky ROM memories are organized in the popular 512 words by 4 bits configuration. A memory enable input is provided to control the output states. When the enable input is in the low state, the outputs present the contents of the selected word.

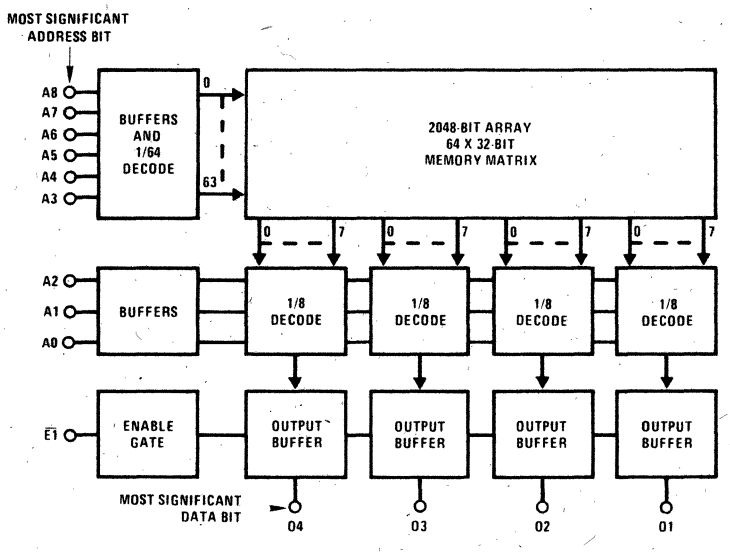
If the enable input is raised to a high level, it causes all 4 outputs to go to the "OFF" or high impedance state. The memories are available in both open-collector and TRI-STATE versions and are available as PROM's as well as ROM's.

features

- Schottky-clamped for high speed
  Address access—55 ns max
  Enable access—30 ns max
- PNP inputs reduce input loading
- All dc and ac parameters guaranteed over temperature
- PROM mates are DM74S570 and DM74S571

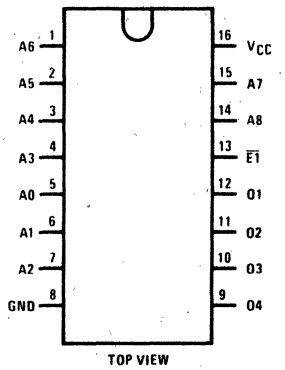
	Military	Commercial	Open-Collector	TRI-STATE	Package
DM74S270		X	X		N, J
DM74S370		X		X	N, J
DM54S270	X		X		J
DM54S370	X			X	J

block diagram



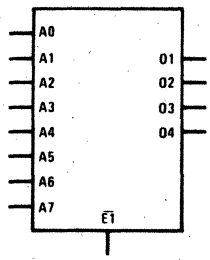
connection diagram

Dual-In-Line Package



TOP VIEW

logic symbol



National Semiconductor

MEMORY

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absolute maximum ratings (Note 1)

Supply Voltage	−0.5V to +7V
Input Voltage	−1.2V to +5.5V
Output Voltage	−0.5V to +5.5V
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM54S270, DM54S370	4.5	5.5	V
DM74S270, DM74S370	4.75	5.25	V
Ambient Temperature (T_A)			
DM54S270, DM54S370	−55	+125	°C
DM74S270, DM74S370	0	+70	°C
Logical "0" Input Voltage (Low)	0	0.8	V
Logical "1" Input Voltage (High)	2.0	5.5	V

dc electrical characteristics (Note 2)

PARAMETER		CONDITIONS	DM54S270, 54S370			DM74S270, 74S370			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{IL}	Input Load Current, All Inputs	V_{CC} = Max, V_{IN} = 0.45V		−80	−250		−80	−250	μA
I_{IH}	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 2.7V			25			25	μA
I_I	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 5.5V			1.0			1.0	mA
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA		0.35	0.5		0.35	0.5	V
V_{IL}	Low Level Input Voltage				0.80			0.80	V
V_{IH}	High Level Input Voltage		2.0			2.0			V
I_{CEX}	Output Leakage Current (Open-Collector Only)	V_{CC} = Max, V_{CEX} = 2.4V			50			50	μA
		V_{CC} = Max, V_{CEX} = 5.5V			100			100	μA
V_C	Input Clamp Voltage	V_{CC} = Min, I_{IN} = −18 mA		−0.8	−1.2		−0.8	−1.2	V
C_{IN}	Input Capacitance	V_{CC} = 5V, V_{IN} = 2V, T_A = 25°C, 1 MHz		4.0			4.0		pF
C_O	Output Capacitance	V_{CC} = 5V, V_O = 2V, T_A = 25°C, 1 MHz, Output "OFF"		6.0			6.0		pF
I_{CC}	Power Supply Current	V_{CC} = Max, All Inputs Grounded, All Outputs Open		80	130		80	130	mA
TRI-STATE PARAMETERS									
I_{SC}	Output Short Circuit Current	V_O = 0V, V_{CC} = Max, (Note 3)	−30	−60	−100	−30	−60	−100	mA
I_{HZ}	Output Leakage (TRI-STATE)	V_{CC} = Max, V_O = 0.45 to 2.4V; Chip Disabled			±50			±50	μA
V_{OH}	Output Voltage High	I_{OH} = −2 mA	2.4	3.2					V
		I_{OH} = −6.5 mA				2.4	3.2		V

ac electrical characteristics (With standard load)

PARAMETER		CONDITIONS	DM54S270, 54S370 5V ±10%; −55°C to +125°C			DM74S270, 74S370 5V ±5%; 0°C to +70°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{AA}	Address Access Time			37	70		37	55	ns
t_{EA}	Enable Access Time			18	35		18	30	ns
t_{ER}	Enable Recovery Time			18	35		18	30	ns

Note 1: Absolute maximum ratings are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

Note 2: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

Note 3: During I_{SC} measurement, only one output at a time should be grounded. Permanent damage may otherwise result.

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DM54S271/DM74S271 open-collector 2048-bit ROM
DM54S371/DM74S371 TRI-STATE® 2048-bit ROM

general description

These Schottky ROM's are organized in the popular 256 words by 8 bits configuration. Two memory enable inputs are provided to control the output states. When both enable inputs are in the low state, the outputs present the contents of the selected word.

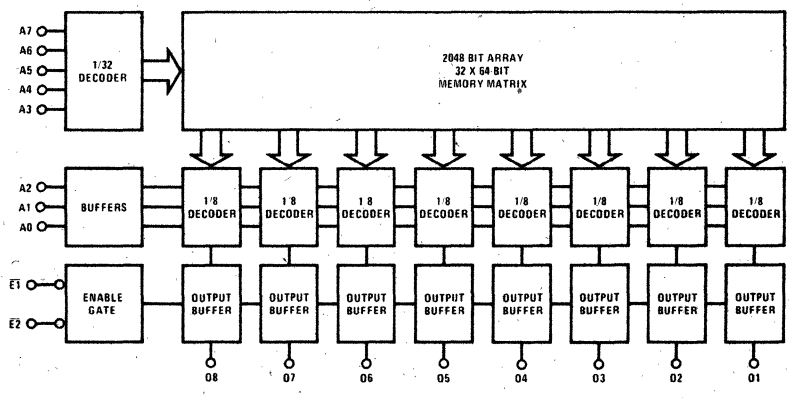
If either or both of the enable inputs is raised to a high level, it causes all 8 outputs to go to the "OFF" or high impedance state. The memories are available in both open-collector and TRI-STATE versions and are available as PROM's as well as ROM's.

features

- Schottky-clamped for high speed
  - Address access—60 ns max
  - Enable access—35 ns max
- PNP inputs reduce input loading
- All dc and ac parameters guaranteed over temperature
- High density 20-pin package
- PROM mates are DM74S470 and DM74S471

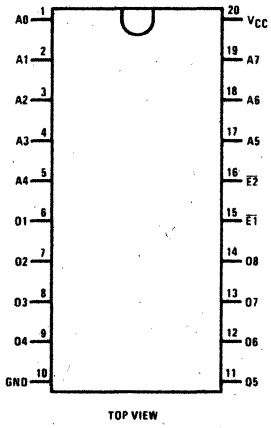
	Military	Commercial	Open-Collector	TRI-STATE	Package
DM74S271		X	X		N, J
DM74S371		X		X	N, J
DM54S271	X		X		J
DM54S371	X			X	J

block diagram



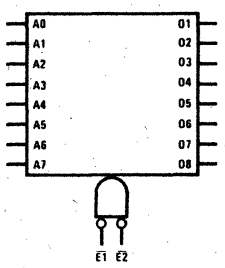
connection diagram

Dual-In-Line Package



TOP VIEW

logic symbol



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absolute maximum ratings (Note 1)

Supply Voltage	0.5V to +7V
Input Voltage	−1.2V to +5.5V
Output Voltage	−0.5V to +5.5V
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM54S271, DM54S371	4.5	5.5	V
DM74S271, DM74S371	4.75	5.25	V
Ambient Temperature (T_A)			
DM54S271, DM54S371	−55	+125	°C
DM74S271, DM74S371	0	+70	°C
Logical "0" Input Voltage (Low)	0	0.8	V
Logical "1" Input Voltage (High)	2.0	5.5	V

dc electrical characteristics (Note 2)

PARAMETER		CONDITIONS	DM54S271, 54S371			DM74S271, 74S371			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{IL}	Input Load Current, All Inputs	V_{CC} = Max, V_{IN} = 0.45V		−80	−250		−80	−250	μA
I_{IH}	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 2.7V			25			25	μA
I_I	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 5.5V			1.0			1.0	mA
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA		0.35	0.5		0.35	0.5	V
V_{IL}	Low Level Input Voltage				0.80			0.80	V
V_{IH}	High Level Input Voltage		2.0			2.0			V
I_{CEX}	Output Leakage Current (Open-Collector Only)	V_{CC} = Max, V_{CEX} = 2.4V			50			50	μA
		V_{CC} = Max, V_{CEX} = 5.5V			100			100	μA
V_C	Input Clamp Voltage	V_{CC} = Min, I_{IN} = −18 mA		−0.8	−1.2		−0.8	−1.2	V
C_{IN}	Input Capacitance	V_{CC} = 5V, V_{IN} = 2V, T_A = 25°C, 1 MHz		4.0			4.0		pF
C_O	Output Capacitance	V_{CC} = 5V, V_O = 2V, T_A = 25°C, 1 MHz, Output "OFF"		6.0			6.0		pF
I_{CC}	Power Supply Current	V_{CC} = Max, All Inputs Grounded, All Outputs Open		120	150		120	150	mA
TRI-STATE PARAMETERS									
I_{SC}	Output Short Circuit Current	V_O = 0V, V_{CC} = Max, (Note 3)	−30	−60	−100	−30	−60	−100	mA
I_{HZ}	Output Leakage (TRI-STATE)	V_{CC} = Max, V_O = 0.45 to 2.4V, Chip Disabled			±50			±50	μA
V_{OH}	Output Voltage High	I_{OH} = −2 mA	2.4	3.2					V
		I_{OH} = −6.5 mA				2.4	3.2		V

ac electrical characteristics (With standard load)

PARAMETER		CONDITIONS	DM54S271, 54S371 5V ±10%; −55°C to +125°C			DM74S271, 74S371 5V ±5%; 0°C to +70°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{AA}	Address Access Time			37	75		37	60	ns
t_{EA}	Enable Access Time			18	40		18	30	ns
t_{ER}	Enable Recovery Time			18	40		18	30	ns

Note 1: Absolute maximum ratings are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

Note 2: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

Note 3: During I_{SC} measurement, only one output at a time should be grounded. Permanent damage may otherwise result.

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DM77S201/DM87S201 open-collector 2048-bit ROM with latches
DM77S202/DM87S202 TRI-STATE® 2048-bit ROM with latches

general description

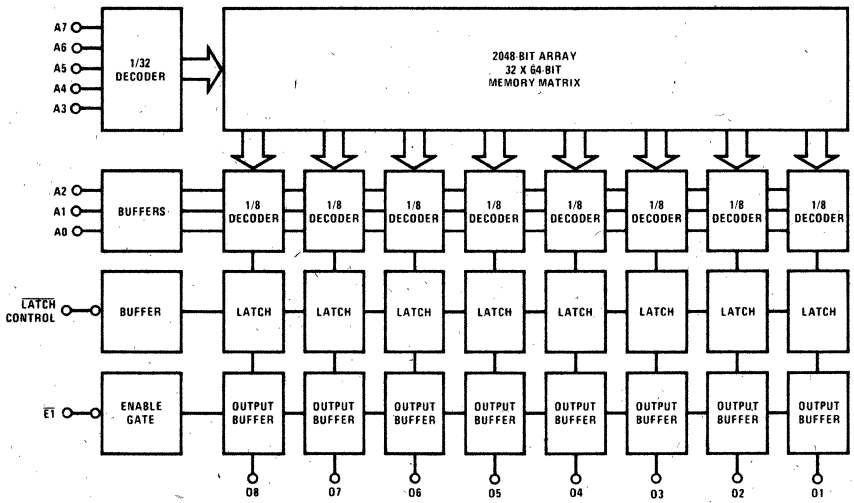
These Schottky ROM memories are organized in the popular 256 words by 8 bits configuration. A memory enable input is provided to control the output states. When the enable input is in the low state, the outputs present the contents of the selected word. An output latch control is provided. If the latch control pin is high, the data falls through to the output enable gate. If the latch control pin is low, the data is latched and the address may be changed without affecting the output data.

features

- Schottky-clamped for high speed
  - Address access—60 ns max
  - Enable access—30 ns max
- PNP inputs reduce input loading
- All dc and ac parameters guaranteed over temperature
- Open-collector or TRI-STATE® outputs
- High density 20-pin package
- PROM mates are DM87S221 and DM87S222

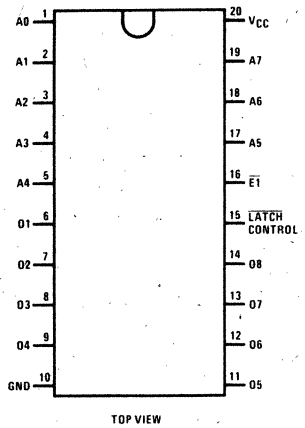
	Military	Commercial	Open-Collector	TRI-STATE	Package
DM87S201		X	X		N, J
DM87S202		X		X	N, J
DM77S201	X		X		J
DM77S202	X			X	J

block diagram



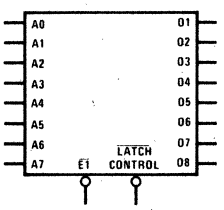
connection diagram

Dual-In-Line Package



TOP VIEW

logic symbol



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absolute maximum ratings (Note 1)

Supply Voltage	−0.5V to +7V
Input Voltage	−1.2V to +5.5V
Output Voltage	−0.5V to +5.5V
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM77S201, DM77S202	4.5	5.5	V
DM87S201, DM87S202	4.75	5.25	V
Ambient Temperature (T_A)			
DM77S201, DM77S202	−55	+125	°C
DM87S201, DM87S202	0	+70	°C
Logical "0" Input Voltage (Low)	0	0.8	V
Logical "1" Input Voltage (High)	2.0	5.5	V

dc electrical characteristics (Note 2)

PARAMETER		CONDITIONS	DM77S201, 77S202			DM87S201, 87S202			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{IL}	Input Load Current, All Inputs	V_{CC} = Max, V_{IN} = 0.45V		−80	−250		−80	−250	μA
I_{IH}	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 2.7V			25			25	μA
I_I	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 5.5V			1.0			1.0	mA
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA		0.35	0.5		0.35	0.5	V
V_{IL}	Low Level Input Voltage				0.80			0.80	V
V_{IH}	High Level Input Voltage		2.0			2.0			V
I_{CEX}	Output Leakage Current (Open-Collector Only)	V_{CC} = Max, V_{CEX} = 2.4V			50			50	μA
		V_{CC} = Max, V_{CEX} = 5.5V			100			100	μA
V_C	Input Clamp Voltage	V_{CC} = Min, I_{IN} = −18 mA		−0.8	−1.2		−0.8	−1.2	V
C_{IN}	Input Capacitance	V_{CC} = 5V, V_{IN} = 2V, T_A = 25°C, 1 MHz		4.0			4.0		pF
C_O	Output Capacitance	V_{CC} = 5V, V_O = 2V, T_A = 25°C, 1 MHz, Output "OFF"		6.0			6.0		pF
I_{CC}	Power Supply Current	V_{CC} = Max, All Inputs Grounded, All Outputs Open		120	150		120	150	mA
TRI-STATE PARAMETERS									
I_{SC}	Output Short Circuit Current	V_O = 0V, V_{CC} = Max, (Note 3)	−30	−60	−100	−30	−60	−100	mA
I_{HZ}	Output Leakage (TRI-STATE)	V_{CC} = Max, V_O = 0.45 to 2.4V, Chip Disabled			±50			±50	μA
V_{OH}	Output Voltage High	I_{OH} = −2 mA	2.4	3.2					V
		I_{OH} = −6.5 mA				2.4	3.2		V

ac electrical characteristics (With standard load)

PARAMETER		CONDITIONS	DM77S201, 77S202 5V ±10%; −55°C to +125°C			DM87S201, 87S202 5V ±5%; 0°C to +70°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{AA}	Address Access Time			38	75		38	60	ns
t_{EA}	Enable Access Time			18	40		18	30	ns
t_{ER}	Enable Recovery Time			18	40		18	30	ns
t_{LO}	Latch To Output			14	30		14	20	ns

Note 1: Absolute maximum ratings are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

Note 2: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

Note 3: During I_{SC} measurement, only one output at a time should be grounded. Permanent damage may otherwise result.

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DM77S95/DM87S95 open-collector 4096-bit ROM
DM77S96/DM87S96 TRI-STATE® 4096-bit ROM

general description

These Schottky ROM memories are organized in the popular 512 words by 8 bits configuration. Four memory enable inputs are provided to control the output states. When E1 and E2 are low and E3 and E4 are high, the output presents the contents of the selected word.

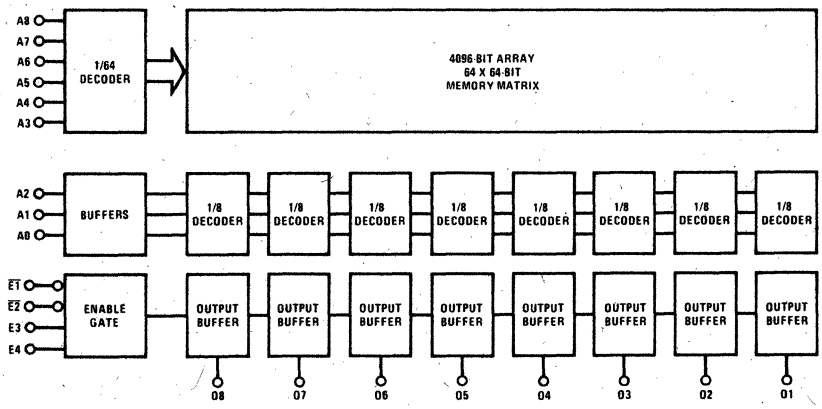
If E1 or E2 are high, or E3 or E4 are low, it causes all 8 outputs to go to the "OFF" or high impedance state. The memories are available in both open-collector and TRI-STATE® versions and are available as PROM's as well as ROM's.

features

- Schottky-clamped for high speed
  Address access—65 ns max
  Enable access—35 ns max
- PNP inputs reduce input loading
- All dc and ac parameters guaranteed over temperature
- PROM mates are DM87S295 and DM87S296

	Military	Commercial	Open-Collector	TRI-STATE	Package
DM87S95		X	X		N, J
DM87S96		X		X	N, J
DM77S95	X		X		J
DM77S96	X			X	J

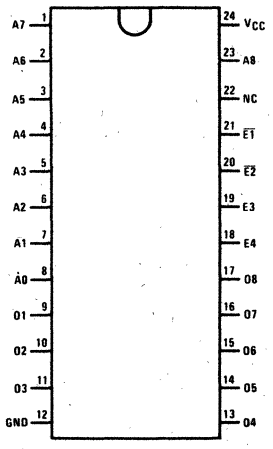
block diagram



The device is enabled when: $\overline{E}_1 \cdot \overline{E}_2 \cdot E_3 \cdot E_4$

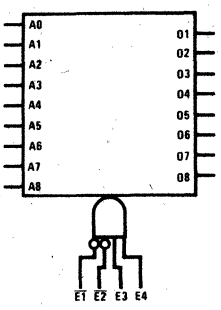
connection diagram

Dual-In-Line Package



TOP VIEW

logic symbol



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absolute maximum ratings (Note 1)

Supply Voltage	0.5V to +7V
Input Voltage	−1.2V to +5.5V
Output Voltage	−0.5V to +5.5V
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM77S95, DM77S96	4.5	5.5	V
DM87S95, DM87S96	4.75	5.25	V
Ambient Temperature (T_A)			
DM77S95, DM77S96	−55	+125	°C
DM87S95, DM87S96	0	+70	°C
Logical "0" Input Voltage (Low)	0	0.8	V
Logical "1" Input Voltage (High)	2.0	5.5	V

dc electrical characteristics (Note 2)

PARAMETER		CONDITIONS	DM77S95, 77S96			DM87S95, 87S96			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{IL}	Input Load Current, All Inputs	V_{CC} = Max, V_{IN} = 0.45V		−80	−250		−80	−250	μA
I_{IH}	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 2.7V			25			25	μA
I_I	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 5.5V			1.0			1.0	mA
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA		0.35	0.5		0.35	0.5	V
V_{IL}	Low Level Input Voltage				0.80			0.80	V
V_{IH}	High Level Input Voltage		2.0			2.0			V
I_{CEX}	Output Leakage Current (Open-Collector Only)	V_{CC} = Max, V_{CEX} = 2.4V			50			50	μA
		V_{CC} = Max, V_{CEX} = 5.5V			100			100	μA
V_C	Input Clamp Voltage	V_{CC} = Min, I_{IN} = −18 mA		−0.8	−1.2		−0.8	−1.2	V
C_{IN}	Input Capacitance	V_{CC} = 5V, V_{IN} = 2V, T_A = 25°C, 1 MHz		4.0			4.0		pF
C_O	Output Capacitance	V_{CC} = 5V, V_O = 2V, T_A = 25°C, 1 MHz, Output "OFF"		6.0			6.0		pF
I_{CC}	Power Supply Current	V_{CC} = Max, All Inputs Grounded, All Outputs Open		110	170		115	170	mA
TRI-STATE PARAMETERS									
I_{SC}	Output Short Circuit Current	V_O = 0V, V_{CC} = Max, (Note 3)	−30	−60	−100	−30	−60	−100	mA
I_{HZ}	Output Leakage (TRI-STATE)	V_{CC} = Max, V_O = 0.45 to 2.4V, Chip Disabled			±50			±50	μA
V_{OH}	Output Voltage High,	I_{OH} = −2 mA	2.4	3.2					V
		I_{OH} = −6.5 mA				2.4	3.2		V

ac electrical characteristics (With standard load)

PARAMETER		CONDITIONS	DM87S95, 87S96 5V ±10%; −55°C to +125°C			DM77S95, 77S96 5V ±5%; 0°C to +70°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{AA}	Address Access Time			37	80		37	65	ns
t_{EA}	Enable Access Time			18	40		18	35	ns
t_{ER}	Enable Recovery Time			18	40		18	35	ns

Note 1: Absolute maximum ratings are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

Note 2: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

Note 3: During I_{SC} measurement, only one output at a time should be grounded. Permanent damage may otherwise result.

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DM75S29/DM85S29 open-collector 8192-bit ROM
DM75S28/DM85S28 TRI-STATE® 8192-bit ROM

general description

These Schottky ROM memories are organized in the popular 1024 words by 8 bits configuration. Four memory enable inputs are provided to control the output states. When E1 and E2 are low and E3 and E4 are high, the output presents the contents of the selected word.

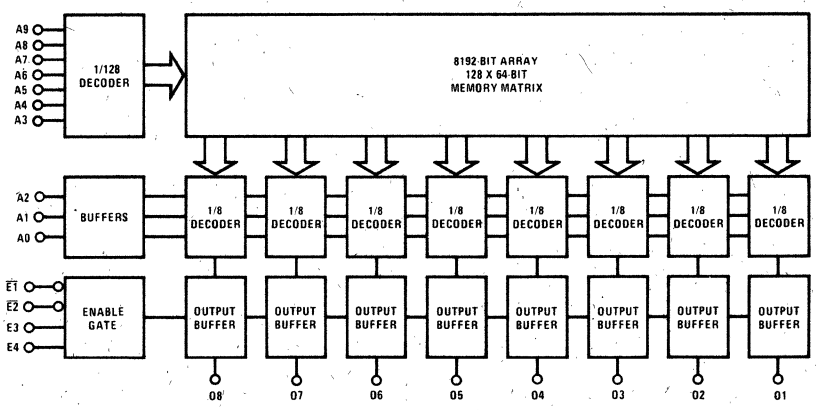
If E1 or E2 are high, or E3 or E4 are low, it causes all 8 outputs to go to the "OFF" or high impedance state. The memories are available in both open-collector and TRI-STATE versions and are available as PROM's as well as ROM's.

features

- Schottky-clamped for high speed
  - Address access—70 ns max
  - Enable access—45 ns max
- PNP inputs reduce input loading
- All dc and ac parameters guaranteed over temperature
- PROM mates are DM87S229 and DM87S228

	Military	Commercial	Open-Collector	TRI-STATE	Package
DM85S29		X	X		N, J
DM85S28		X		X	N, J
DM75S29	X		X		J
DM75S28	X			X	J

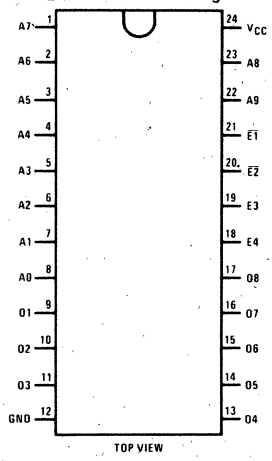
block diagram



The device is enabled when: $\overline{E1} \cdot \overline{E2} \cdot E3 \cdot E4$

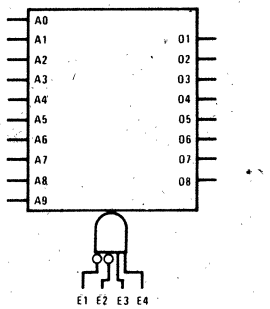
connection diagram

Dual-In-Line Package



TOP VIEW

logic symbol



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absolute maximum ratings (Note 1)

Supply Voltage	−0.5V to +7V
Input Voltage	−1.2V to +5.5V
Output Voltage	−0.5V to +5.5V
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM75S29, DM75S28	4.5	5.5	V
DM85S29, DM85S28	4.75	5.25	V
Ambient Temperature (T_A)			
DM75S29, DM75S28	−55	+125	°C
DM85S29, DM85S28	0	+70	°C
Logical "0" Input Voltage (Low)	0	0.8	V
Logical "1" Input Voltage (High)	2.0	5.5	V

dc electrical characteristics (Note 2)

PARAMETER		CONDITIONS	DM75S29, 75S28			DM85S29, 85S28			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{IL}	Input Load Current, All Inputs	V_{CC} = Max, V_{IN} = 0.45V		−80	−250		−80	−250	μA
I_{IH}	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 2.7V			25			25	μA
I_I	Input Leakage Current, All Inputs	V_{CC} = Max, V_{IN} = 5.5V			1.0			1.0	mA
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA		0.35	0.5		0.35	0.5	V
V_{IL}	Low Level Input Voltage				0.80			0.80	V
V_{IH}	High Level Input Voltage		2.0			2.0			V
I_{CEX}	Output Leakage Current (Open-Collector Only)	V_{CC} = Max, V_{CEX} = 2.4V			50			50	μA
		V_{CC} = Max, V_{CEX} = 5.5V			100			100	μA
V_C	Input Clamp Voltage	V_{CC} = Min, I_{IN} = −18 mA		−0.8	−1.2		−0.8	−1.2	V
C_{IN}	Input Capacitance	V_{CC} = 5V, V_{IN} = 2V, T_A = 25°C, 1 MHz		4.0			4.0		pF
C_O	Output Capacitance	V_{CC} = 5V, V_O = 2V, T_A = 25°C, 1 MHz, Output "OFF"		6.0			6.0		pF
I_{CC}	Power Supply Current	V_{CC} = Max, All Inputs Grounded, All Outputs Open		140	170		140	170	mA
TRI-STATE PARAMETERS									
I_{SC}	Output Short Circuit Current	V_O = 0V, V_{CC} = Max, (Note 3)	−30	−60	−100	−30	−60	−100	mA
I_{HZ}	Output Leakage (TRI-STATE)	V_{CC} = Max, V_O = 0.45 to 2.4V, Chip Disabled			±50			±50	μA
V_{OH}	Output Voltage High	I_{OH} = −2 mA	2.4	3.2					V
		I_{OH} = −6.5 mA				2.4	3.2		V

ac electrical characteristics (With standard load)

PARAMETER		CONDITIONS	DM75S29, 75S28 5V ±10%; −55°C to +125°C			DM85S29, 85S28 5V ±5%; 0°C to +70°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{AA}	Address Access Time			47	90		47	70	ns
t_{EA}	Enable Access Time			30	50		30	45	ns
t_{ER}	Enable Recovery Time			30	50		30	45	ns

Note 1: Absolute maximum ratings are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

Note 2: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

Note 3: During I_{SC} measurement, only one output at a time should be grounded. Permanent damage may otherwise result.

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Bipolar ROMs

DM7575/DM8575, DM7576/DM8576 programmable logic array (PLA)

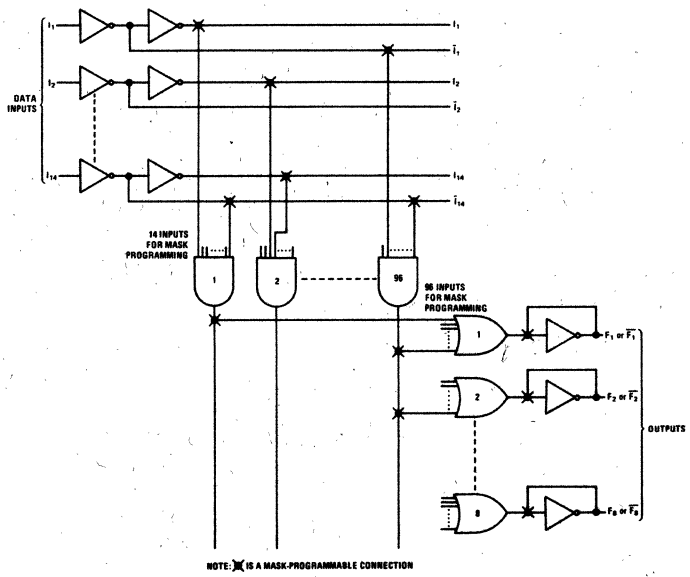
general description

The DM7575/DM8575 and DM7576/DM8576 are mask-programmable logic arrays designed for use in applications where random logic is required. The devices have fourteen data inputs and eight outputs. Each output provides a sum of product terms where each product term can contain any combination of 14 variables or their complements. The total number of product terms which can be provided is 96. Any product term which is repeated is counted only once. Since some functions are more easily represented in their inverted form, an option is provided to allow for either the true or complement of the function on each output. The products are particularly useful in providing control logic for digital systems. The DM7575/DM8575 has a conventional totem-pole output whereas the DM7576/DM8576 is provided with a passive pullup output. This latter configuration is useful in expanding functions by connection of outputs of different packages.

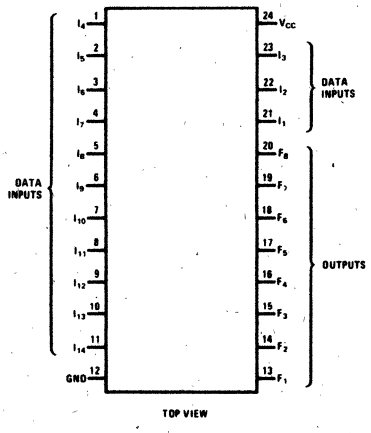
features

- A 2^{14}-by-8 (128k) bit memory would be needed to provide equivalent function
- Typical delay 90 ns
- Typical power dissipation 550 mW
- Series 54/74 compatible

logic and connection diagrams



Dual-In-Line Package



Order Number DM7575J, DM8575J, DM7576J or DM8576J
See Package 11
Order Number DM8575N or DM8576N
See Package 18

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absolute maximum ratings (Note 1)

Supply Voltage	7.0V
Input Voltage	5.5V
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 sec)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM7575, DM7576	4.5	5.5	V
DM8575, DM8576	4.75	5.25	V
Temperature (T_A)			
DM7575, DM7576	−55	+125	°C
DM8575, DM8576	0	70	°C

electrical characteristics (Note 2)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Logical "1" Input Voltage	V_{CC} = Min	2			V
Logical "0" Input Voltage	V_{CC} = Min			0.8	V
Logical "1" Output Voltage (DM7575/DM8575 Only)	V_{CC} = Min, $V_{IN(1)}$ = 2V, $V_{IN(0)}$ = 0.8V, I_{OUT} = −800μA	2.4			V
Logical "1" Output Current (DM7576/DM8576 Only)	V_{CC} = Max, V_{OUT} = 5.5V			100	μA
Logical "0" Output Voltage	V_{CC} = Min, $V_{IN(1)}$ = 2V, $V_{IN(0)}$ = 0.8V, I_{OUT} = +12 mA			0.4	V
Logical "1" Input Current	V_{CC} = Max, V_{IN} = 2.4V			40	μA
	V_{CC} = Max, V_{IN} = 5.5V			1	mA
Logical "0" Input Current	V_{CC} = Max, V_{IN} = 0.4V			−1.0	mA
Output Short Circuit Current DM7575/76	V_{CC} = Max, V_{OUT} = 0V	−20/−1.75		−55/−3.5	mA
(Note 3) DM8575/76		−18/−1.65		−55/−3.3	
Supply Current	V_{CC} = Max		110	170	mA
Input Diode Clamp Voltage	V_{CC} = Min, T_A = 25°C, I_{IN} = −12 mA			−1.5	V
Propagation Delay to a Logical "0" from Data Inputs to Outputs, t_{pd0}	V_{CC} = 5.0V, T_A = 25°C, C_L = 50 pF, R_L = 400Ω		100	150	ns
Propagation Delay to a Logical "1" from Data Inputs to Outputs, t_{pd1}	V_{CC} = 5.0V, T_A = 25°C		80	150	ns

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: Unless otherwise specified min/max limits apply across the −55°C to +125°C temperature range for the DM7575/76 and across the 0°C to 70°C range for the DM8575/76. All typicals are given for V_{CC} = 5.0V and T_A = 25°C.

Note 3: Only one output at a time should be shorted.

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Bipolar RAMs

DM5489/DM7489 (SN5489/SN7489)
64-bit random access read/write memory

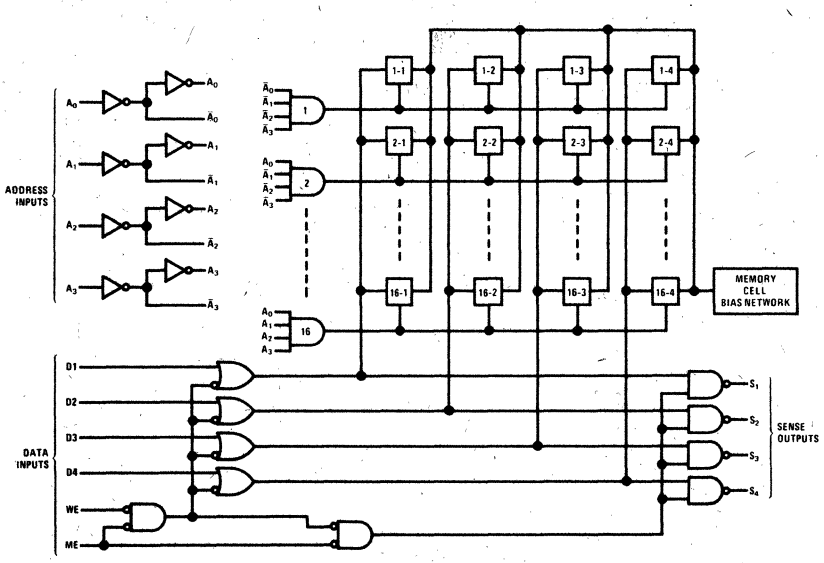
general description

The DM5489/DM7489 is a fully decoded 64-bit RAM organized as 16 4-bit words. The memory is addressed by applying a binary number to the four Address inputs. After addressing, information may be either written into or read from the memory. To write, both the Memory Enable and the Write Enable inputs must be in the logical "0" state. Information applied to the four Write inputs will then be written into the addressed location. To read information from the memory the Memory Enable input must be in the logical "0" state and the Write Enable input in the logical "1" state. Information will be read as the complement of what was written into the memory. When the Memory Enable input is in the logical "1" state, the outputs will go to the logical "1" state.

features

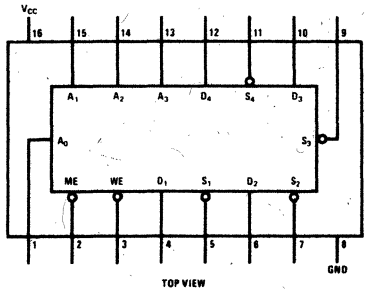
- Series 54/74 compatible
- Organized as 16 4-bit words
- Typical access from chip enable 23 ns
- Typical access 35 ns
- Typical power dissipation 400 mW
- Open collector outputs to permit "wire OR" capability

block diagram



connection diagram

Dual-In-Line Package



Order Number DM5489J or DM7489J
See Package 10
Order Number DM7489N
See Package 15

truth table

MEMORY ENABLE	WRITE ENABLE	OPERATION	OUTPUTS
0	0	Write	Logical "1" State
0	1	Read	Complement of Data Stored in Memory
1	X	Hold	Logical "1" State

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absolute maximum ratings (Note 1)

Supply Voltage	7V
Input Voltage	5.5V
Output Voltage	5.5V
Operating Temperature Range	
DM5489	−55°C to +125°C
DM7489	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 sec)	300°C

electrical characteristics (Note 2)

PARAMETER		CONDITIONS		MIN	TYP	MAX	UNITS
Logical "1" Input Voltage	DM5489	V_{CC} = 4.5V		2.0			V
	DM7489	V_{CC} = 4.75V					
Logical "0" Input Voltage	DM5489	V_{CC} = 4.5V				0.8	V
	DM7489	V_{CC} = 4.75V					
Logical "1" Output Current	DM5489	V_{CC} = 5.5V	V_O = 5.25V			100	μA
	DM7489	V_{CC} = 5.25V				20	μA
Logical "0" Output Voltage	DM5489	V_{CC} = 4.5V	I_O = 12 mA			0.4	V
	DM7489	V_{CC} = 4.75V					
Logical "1" Input Current	DM5489	V_{CC} = 5.5V	V_{IN} = 2.4V			40	μA
	DM7489	V_{CC} = 5.25V					
	DM5489	V_{CC} = 5.5V	V_{IN} = 5.5V			1	mA
	DM7489	V_{CC} = 5.25V					
Logical "0" Input Current	DM5489	V_{CC} = 5.5V				−1.6	mA
	DM7489	V_{CC} = 5.25V					
Supply Current	DM5489	V_{CC} = 5.5V	All Inputs at GND		80	120	mA
	DM7489	V_{CC} = 5.25V					
Input Clamp Voltage	DM5489	V_{CC} = 4.5V	I_{IN} = −12 mA			V_{CC} −1.5	V
	DM7489	V_{CC} = 4.75V					

switching characteristics (Over recommended operating ranges of V_{CC} and T_A)

PARAMETER			CONDITIONS	DM5489			DM7489			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
t_{PLH}	Access Time From Address		R_{L1} = 300Ω R_{L2} = 600Ω C_L = 30 pF		34	80		34	60	ns
t_{PHL}					35	80		35	60	ns
t_{PLH}	Disable Time From Memory Enable				23	55		23	40	ns
t_{PHL}	Enable Time From Memory Enable				23	55		23	40	ns
t_{SETUP}	Setup Time	Address to Write Enable		0	−14		0	−14		ns
		Data to Write Enable		0	−15		0	−15		ns
		Memory Enable To Write Enable		0	−10		0	−10		ns
t_{HOLD}	Hold Time	Address From Write Enable		5	−7		5	−7		ns
		Data From Write Enable		0	−14		0	−14		ns
		Memory Enable From Write Enable		0	−10		0	−10		ns
t_{WP}	Write Pulse Width			50	20		40	20		ns
t_{SR}	Sense Recovery Time				31	65		31	55	ns

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: Unless otherwise specified min/max limits apply across the −55°C to +125°C temperature range for the DM5489 and across the 0°C to 70°C range for the DM7489. All typicals are given for V_{CC} = 5.0V and T_A = 25°C.

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Preliminary

DM54LS189/DM74LS189 low power 64-bit random access memories with TRI-STATE® outputs

general description

These 64-bit active-element memories are monolithic Schottky-clamped transistor-transistor logic (TTL) arrays organized as 16 words of 4 bits each. They are fully decoded and feature a chip enable input to simplify decoding required to achieve the desired system organization. This device is implemented with low power Schottky technology resulting in one-fifth power while retaining the speed of standard TTL.

The TRI-STATE output combines the convenience of an open-collector with the speed of a totem-pole output; it can be bus-connected to other similar outputs, yet it retains the fast rise time characteristics of the TTL totem-pole output. Systems utilizing data bus lines with a defined pull-up impedance can employ the open-collector DM54LS289.

Write Cycle: The complement of the information at the data input is written into the selected location when both the chip enable input and the read/write input are low. While the read/write input is low, the outputs are in the high impedance state. When a number of the DM54LS189 outputs are bus-connected, this high impedance state will neither load nor drive the bus line, but it will allow the bus line to be driven by another active output or a passive pull-up if desired.

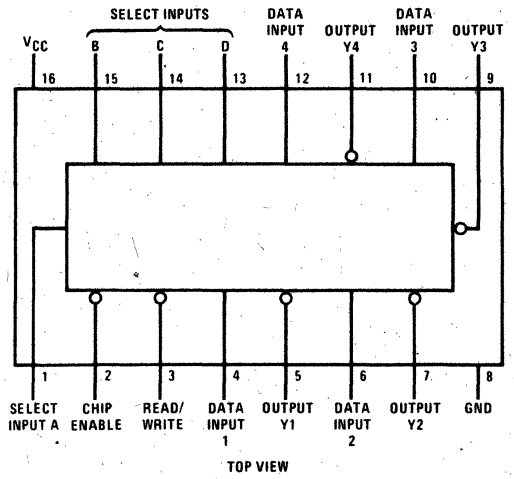
Read Cycle: The stored information (complement of information applied at the data inputs during the write cycle) is available at the outputs when the read/write input is high and the chip enable is low. When the chip enable input is high, the outputs will be in the high impedance state.

features

- Schottky-clamped for high speed applications
  - Access from chip enable input—40 ns typ
  - Access from address inputs—60 ns typ
- TRI-STATE outputs drive bus-organized systems and/or high capacitive loads
- Low power—75 mW typ
- DM54LS189 is guaranteed for operation over the full military temperature range of −55°C to +125°C
- Compatible with most TTL and DTL logic circuits
- Chip enable input simplifies system decoding

connection diagram

Dual-In-Line and Flat Package



TOP VIEW

truth table

FUNCTION	INPUTS		OUTPUT
	CHIP ENABLE	READ/ WRITE	
Write (Store Complement of Data)	L	L	H
Read	L	H	Stored Data
Inhibit	H	X	H

H = high level
L = low level
X = don't care

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absolute maximum ratings (Note 1)

Supply Voltage, V_{CC}	7V
Input Voltage	5.5V
Output Voltage	5.5V
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM54LS189	4.5	5.5	V
DM74LS189	4.75	5.25	V
Temperature (T_A)			
DM54LS189	55	+125	°C
DM74LS189	0	+70	°C

electrical characteristics

Over recommended operating free-air temperature range (unless otherwise noted) (Notes 2 and 3)

PARAMETER		CONDITIONS		MIN	TYP	MAX	UNITS
V_{IH}	High Level Input Voltage			2			V
V_{IL}	Low Level Input Voltage					0.8	V
V_{OH}	High Level Output Voltage	V_{CC} = Min	I_{OH} = −2 mA	2.4	3.4		V
				2.4	3.2		
V_{OL}	Low Level Output Voltage	V_{CC} = Min	I_{OL} = 4 mA DM54LS189			0.45	V
			I_{OL} = 8 mA DM74LS189			0.5	
I_{IH}	High Level Input Current	V_{CC} = Max, V_I = 2.7				10	μA
I_I	High Level Input Current at Maximum Voltage	V_{CC} = Max, V_I = 5.5V				1.0	mA
I_{IL}	Low Level Input Current	V_{CC} = Max, V_I = 0.45V				−100	μA
I_{OS}	Short-Circuit Output Current (Note 4)	V_{CC} = Max, V_O = 0V		−30		−100	mA
I_{CC}	Supply Current (Note 5)	V_{CC} = Max			15	25	mA
V_{IC}	Input Clamp Voltage	V_{CC} = Min, I_I = −18 mA				−1.2	V
I_{OZH}	TRI-STATE Output Current, High Level Voltage Applied	V_{CC} = Max, V_O = 2.4V				40	μA
I_{OZL}	TRI-STATE Output Current, Low Level Voltage Applied	V_{CC} = Max, V_O = 0.45V				40	μA

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switching characteristics

Over recommended operating ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER			CONDITIONS	DM54LS189			DM74LS189			UNITS
				MIN	TYP(1)	MAX	MIN	TYP(1)	MAX	
t_{AA}	Access Times From Address				60	100		60	10	ns
t_{CZH}	Output Enable Time to High Level	Access Times From Chip Enable	C_L = 30 pF, R_L = 1 kΩ,		40	80		40	60	ns
t_{CZL}	Output Enable Time to Low Level				40	80		40	60	ns
t_{WZH}	Output Enable Time to High Level	Sense Recovery Times From Read/Write			60	100		60	80	ns
t_{WZL}	Output Enable Time to Low Level				60	100		60	80	ns
t_{CHZ}	Output Disable Time From High Level	Disable Times From Chip Enable	C_L = 5 pF, R_L = 1 kΩ,		40	80		40	60	ns
t_{CLZ}	Output Disable Time From Low Level				40	80		40	60	ns
t_{WHZ}	Output Disable Time From High Level	Disable Times From Read/Write			40			40		ns
t_{WLZ}	Output Disable Time From Low Level				40			40		
t_{WP}	Width of Write Enable Pulse (Read/Write Low)			100			80			ns
t_{ASW}	Set-Up Time	Address to Read/Write		0			0			ns
t_{DSW}		Data to Read/Write		100			80			
t_{CSW}		Chip Enable to Read/Write		0			0			
t_{AHW}	Hold Time	Address From Read/Write		0			0			ns
t_{DHW}		Data From Read/Write		0			0			
t_{CHW}		Chip Enable From Read/Write		0			0			

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: Unless otherwise specified min/max limits apply across the −55°C to +125°C temperature range for the DM54LS189 and across the 0°C to +70°C range for the DM74LS189. All typicals are given for V_{CC} = 5V and T_A = 25°C.

Note 3: All currents into device pins shown as positive, out of device pins as negative, all voltages referenced to ground unless otherwise noted. All values shown as max or min on absolute value basis.

Note 4: Only one output at a time should be shorted.

Note 5: I_{CC} is measured with all inputs grounded, and the outputs open.

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DM54S189/DM74S189 64-bit random access memories with TRI-STATE® outputs

general description

These 64-bit active-element memories are monolithic Schottky-clamped transistor-transistor logic (TTL) arrays organized as 16 words of four-bits each. They are fully decoded and feature a chip-enable input to simplify decoding required to achieve the desired system organization. The memories feature PNP input transistors that reduce the low level input current requirement to a maximum of −0.25 mA, only one-eighth that of a DM54S/DM74S standard load factor. The chip-enable circuitry is implemented with minimal delay times to compensate for added system decoding.

The TRI-STATE output combines the convenience of an open-collector with the speed of a totem-pole output; it can be bus-connected to other similar outputs, yet it retains the fast-rise-time characteristics of the TTL totem-pole output. Systems utilizing data-bus lines with a defined pull-up impedance can employ the open-collector DM54S289.

Write Cycle: The complement of the information at the data input is written into the selected location when both the chip-enable input and the read/write input are low. While the read/write input is low, the outputs are in the high-impedance state. When a number of the DM54S189 outputs are bus-connected, this high-impedance state will neither load nor drive the bus line, but it will allow the bus line to be driven by another active output or a passive pull-up if desired.

Read Cycle: The stored information (complement of information applied at the data inputs during the write cycle) is available at the outputs when the read/write input is high and the chip-enable is low. When the chip-enable input is high, the outputs will be in the high-impedance state.

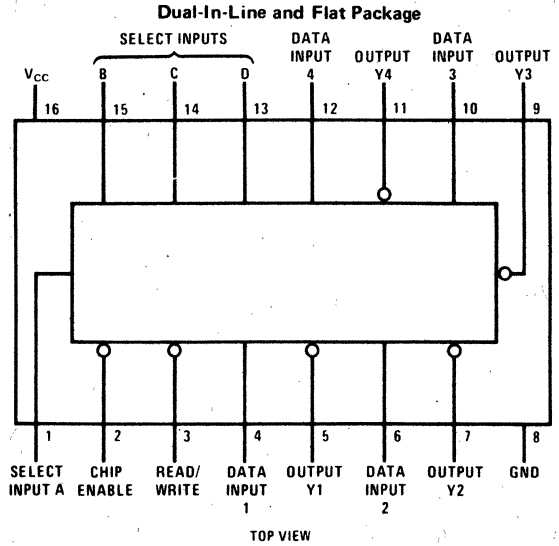
The fast access time of the DM54S189 makes it particularly attractive for implementing high-performance memory functions requiring access times on the order of 25 ns. The high capacitive-drive capability of the outputs permits expansion without additional output buffering. The unique functional capability of the DM54S189 outputs being at a high impedance during writing combined with the data inputs being inhibited during reading means that both data inputs and outputs can be connected to the data lines of a bus-organized system without the need for interface circuits.

features

- Schottky-clamped for high-speed applications:
  - access from chip-enable input 12 ns typ
  - access from address inputs 25 ns typ
- TRI-STATE outputs drive bus-organized systems and/or high capacitive loads
- DM54S289, DM74S289 are functionally equilvalent, have open-collector outputs, and are compatible with Intel 3101A in most applications
- DM54S189 is guaranteed for operation over the full military temperature range of −55°C to +125°C
- Compatible with most TTL and DTL logic circuits
- Chip-enable input simplifies system decoding

connection diagram

Dual-In-Line and Flat Package



TOP VIEW

truth table

FUNCTION	INPUTS		OUTPUT
	CHIP ENABLE	READ/ WRITE	
Write (Store Complement of Data)	L	L	High Impedance
Read	L	H	Stored Data
Inhibit	H	X	High Impedance

H High Level
L Low Level
X Don't Care

Order Number DM54S189J or DM74S189J
See Package 10
Order Number DM74S189N
See Package 15

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absolute maximum ratings (Note 1)

Supply Voltage, V_{CC}	7.0V
Input Voltage	5.5V
Output Voltage	5.5V
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM54S189	4.5	5.5	V
DM74S189	4.75	5.25	V
Temperature (T_A)			
DM54S189	−55	+125	°C
DM74S189	0	+70	°C

electrical characteristics

over recommended operating free-air temperature range (unless otherwise noted) (Notes 2 and 3)

PARAMETER		CONDITIONS		LIMITS MIN	LIMITS TYP	LIMITS MAX	UNITS
V_{IH}	High Level Input Voltage			2			V
V_{IL}	Low-Level Input Voltage					0.8	V
V_{OH}	High-Level Output Voltage	V_{CC} = Min	I_{OH} = −2.0 mA, DM54S189	2.4	3.4		V
			I_{OH} = −6.5 mA, DM74S189	2.4	3.2		
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA	DM54S189			0.5	V
			DM74S189			0.45	
I_{IH}	High Level Input Current	V_{CC} = Max, V_I = 2.7				25	μA
I_I	High Level Input Current at Maximum Voltage	V_{CC} = Max, V_I = 5.5V				1.0	mA
I_{IL}	Low Level Input Current	V_{CC} = Max, V_I = 0.45V				−250	μA
I_{OS}	Short Circuit Output Current (Note 4)	V_{CC} = Max, V_O = 0V		−30		−100	mA
I_{CC}	Supply Current (Note 5)	V_{CC} = Max			75	110	mA
V_{IC}	Input Clamp Voltage	V_{CC} = Min, I_I = −18 mA				−1.2	V
I_{OZH}	TRI-STATE Output Current, High Level Voltage Applied	V_{CC} = Max, V_O = 2.4V				50	μA
I_{OZL}	TRI-STATE Output Current, Low Level Voltage Applied	V_{CC} = Max, V_O = 0.45V				−50	μA

switching characteristics

over recommended operating ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER			CONDITIONS	LIMITS DM54S189 MIN	DM54S189 TYP(1)	DM54S189 MAX	DM74S189 MIN	DM74S189 TYP(1)	DM74S189 MAX	UNITS
t_{AA}	Access Times From Address		C_L = 30 pF, R_L = 280Ω, *(Figure 1)*		25	50		25	35	ns
t_{CZH}	Output Enable Time to High Level	Access Times From Chip Enable			12	25		12	17	ns
t_{CZL}	Output Enable Time to Low Level				12	25		12	17	ns
t_{WZH}	Output Enable Time to High Level	Sense Recovery Times From Read/Write			22	40		22	35	ns
t_{WZL}	Output Enable Time to Low Level				22	40		22	35	ns

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switching characteristics (con't)

PARAMETER			CONDITIONS	LIMITS						UNITS
				DM54S189			DM74S189			
				MIN	TYP(1)	MAX	MIN	TYP(1)	MAX	
t_{CHZ}	Output Disable Time From High Level	Disable Times From Chip Enable	C_L = 5 pF, R_L = 280Ω *(Figure 1)*		12	25		12	17	ns
t_{CLZ}	Output Disable Time From Low Level				12	25		12	17	ns
t_{WHZ}	Output Disable Time From High Level	Disable Times From Read/Write			12			12		ns
t_{WLZ}	Output Disable Time From Low Level				12			12		ns
t_{WP}	Width of Write-Enable Pulse (Read/Write Low)			25			25			ns
t_{ASW}	Set-Up Time *(Figure 1)*	Address to Read/Write		0			0			ns
t_{DSW}		Data to Read/Write		25			25			
t_{CSW}		Chip-Enable to Read/Write		0			0			
t_{AHW}	Hold Time *(Figure 1)*	Address From Read/Write		0			0			ns
t_{DHW}		Data From Read/Write		0			0			
t_{CHW}		Chip-Enable From Read/Write		0			0			

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

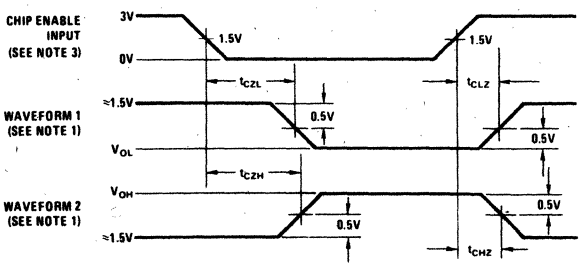
Note 2: Unless otherwise specified min/max limits apply across the −55°C to +125°C temperature range for the DM54S189 and across the 0°C to +70°C range for the DM74S189. All typicals are given for V_{CC} = 5.0V and T_A = 25°C.

Note 3: All currents into device pins shown as positive, out of device pins as negative, all voltages referenced to ground unless otherwise noted. All values shown as max or min on absolute value basis.

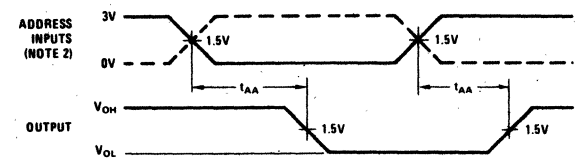
Note 4. Only one output at a time should be shorted.

Note 5: I_{CC} is measured with all inputs grounded, and the outputs open.

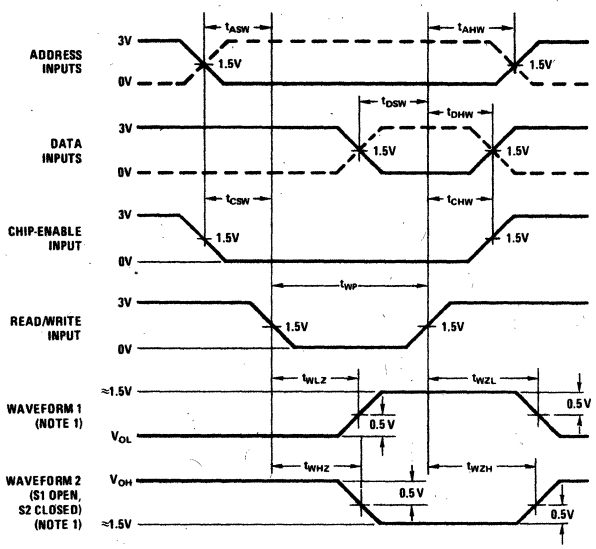
switching time waveforms



Enable and Disable Time From Chip Enable



Access Time From Address Inputs



Write Cycle

FIGURE 1

Note 1: Waveform 1 is for the output with internal conditions such that the output is low except when disabled. Waveform 2 is for the output with internal conditions such that the output is high except when disabled.

Note 2. When measuring delay times from address inputs, the chip enable input is low and the read/write input is high.

Note 3: When measuring delay times from chip enable input, the address inputs are steady-state and the read/write input is high.

Note 4: Input waveforms are supplied by pulse generators having the following characteristics: $t_r \leq 2.5$ ns, $t_f \leq 2.5$ ns, PRR ≤ 1 MHz, and $Z_{OUT} \approx 50\Omega$.

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DM75S68/DM85S68 64-bit (16×4) edge triggered register

general description

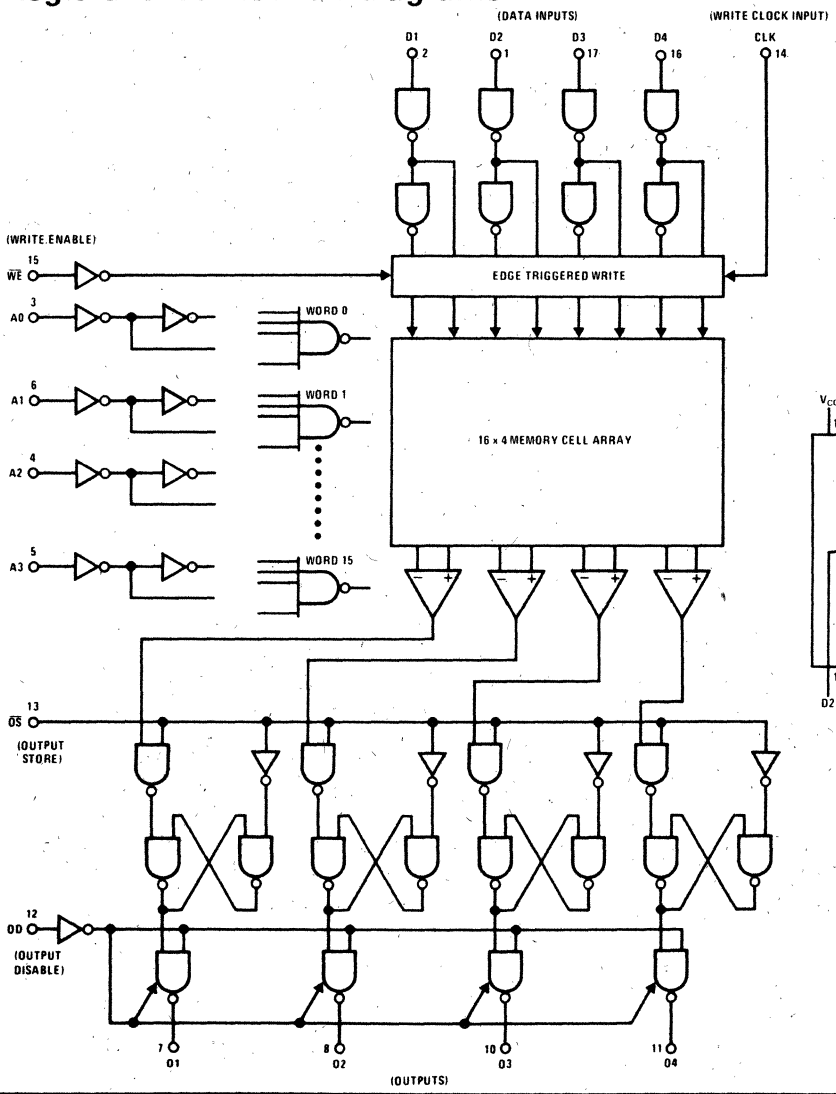
The DM75S68/DM85S68 is an addressable "D" register file. Any of its 16 four-bit words may be asynchronously read or may be written into on the next clock transition. An input terminal is provided to enable or disable the synchronous writing of the input data into the location specified by the address terminals. An output disable terminal operates only as a TRI-STATE® output control terminal. The addressable register data may be latched at the outputs and retained as long as the output store terminal is held in a low state. This memory storage condition is independent of the state of the output disable terminal.

All input terminals are high impedance at all times, and all outputs have low impedance active drive logic states and the high impedance TRI-STATE condition.

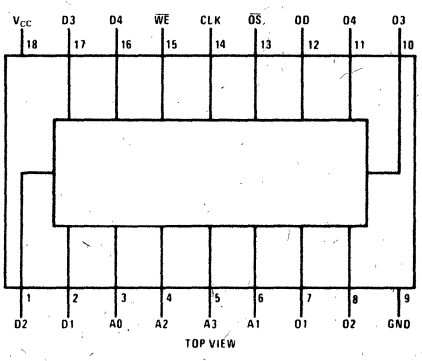
features

- On chip output register
- Edge triggered write
- High speed — 30 ns typ
- TRI-STATE output
- Optimized for register stack applications
- Typical power dissipation — 350 mW
- 18-pin package

logic and connection diagrams



Dual-In-Line Package



Order Number DM75S68D or DM85S68D
See Package 4

Order Number DM85S68N
See Package 16

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absolute maximum ratings (Note 1)

Supply Voltage	7.0V
Input Voltage	5.5V
Output Voltage	5.5V
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage, V_{CC}			
DM85S68	4.75	5.25	V
DM75S68	4.5	5.5	V
Temperature, T_A			
DM85S68	0	70	°C
DM75S68	−55	+125	°C

electrical characteristics

over recommended operating free-air temperature range (unless otherwise noted) (Notes 2 and 3)

PARAMETER		CONDITIONS		LIMITS MIN	LIMITS TYP	LIMITS MAX	UNITS
V_{IH}	High Level Input Voltage			2			V
V_{IL}	Low Level Input Voltage					0.8	V
V_{OH}	High Level Output Voltage	V_{CC} = Min	I_{OH} = −2.0 mA, DM75S68 I_{OH} = −5.2 mA, DM85S68	2.4			V
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = 16 mA	DM75S68			0.5	V
			DM85S68			0.45	
I_{IH}	High Level Input Current	V_{CC} = Max, V_{IH} = 2.4V	Clock Input			50	μA
			All Others			25	
I_I	High Level Input Current at Maximum Voltage	V_{CC} = Max, V_{IH} = 5.5V				1.0	mA
I_{IL}	Low Level Input Current	V_{CC} = Max, V_{IL} = 0.5V	Clock Input			−500	μA
			All Others			−250	μA
I_{OS}	Short Circuit Output Current(4)	V_{CC} = Max, V_{OL} = 0V		−20		−55	mA
I_{CC}	Supply Current	V_{CC} = Max			70	100	mA
V_{IC}	Input Clamp Voltage	V_{CC} = Min, I_{IN} = −18 mA				−1.2	V
I_{OZ}	TRI-STATE Output Current	V_{CC} = Max	V_O = 2.4V			+40	μA
			V_O = 0.5V			−40	

switching characteristics over recommended operating range of T_A and V_{CC} (unless otherwise noted)

PARAMETER			DM75S68 MIN	DM75S68 TYP	DM75S68 MAX	DM85S68 MIN	DM85S68 TYP	DM85S68 MAX	UNITS
t_{ZH}	Output Enable to High Level			20	40		20	35	ns
t_{ZL}	Output Enable to Low Level			14	30		14	24	ns
t_{HZ}	Output Disable Time From High Level			10	18		10	15	ns
t_{LZ}	Output Disable Time From Low Level			12	22		12	18	ns
t_{AA}	Access Time	Address to Output		30	55		30	40	
t_{OSA}		Output Store to Output		20	35		20	30	ns
t_{CA}		Clock to Output		25	50		25	40	
t_{ASC}	Set-Up Time	Address to Clock	25	5		15	5		ns
t_{DSC}		Data to Clock	15	5		5	0		
t_{ASOS}		Address to Output Store	40	15		30	15		
t_{WESC}		Write Enable Set-Up Time	10	5		5	0		
t_{OSSC}		Store Before Write	15	0		10	0		
t_{AHC}	Hold Time	Address From Clock	15	5		10	5		ns
t_{DHC}		Data From Clock	20	5		15	5		
t_{AHOS}		Address From Output Store	10	0		5	0		
t_{WEHC}		Write Enable Hold Time	20	5		15	5		

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: Unless otherwise specified min/max limits apply across the −55°C to +125°C temperature range for the DM75S68 and across the 0°C to +70°C range for the DM85S68. All typicals are given for V_{CC} = 5.0V and T_A = 25°C.

Note 3: All currents into device pins shown as positive, out of device pins as negative, all voltages referenced to ground unless otherwise noted. All values shown as max or min on absolute value basis.

Note 4: Only one output at a time should be shorted.

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DM54S206/DM74S206 256-bit read/write schottky memories with open-collector outputs

general description

The DM54S206/DM74S206 256-bit active-element memories are monolithic transistor-transistor logic (TTL) integrated circuits organized as 256 words of one bit each. They are fully decoded and have three gated memory-enable inputs to simplify decoding required to achieve the desired system organization. The memories feature PNP input transistors which reduce the low-level input current requirement to a maximum of −0.25 milliamperes, only one-eighth that of a normalized Series 54S/74S load factor. The memory-enable circuitry is implemented with minimal delay times to compensate for added system decoding.

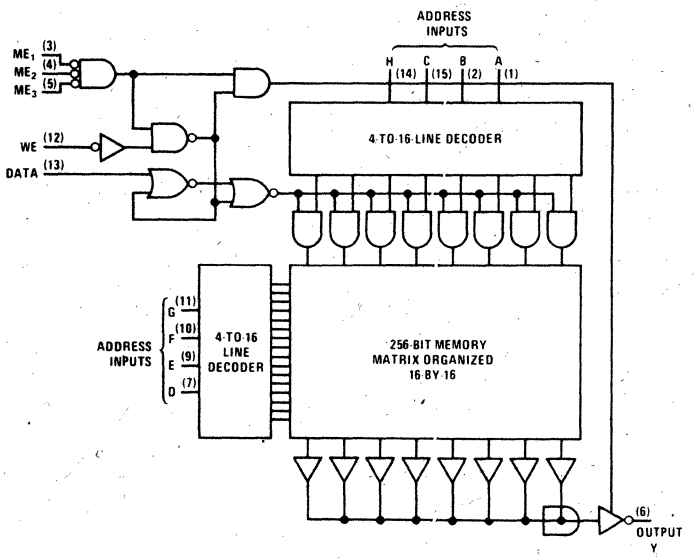
Write Cycle: The complement of the information at the data input is written into the selected location when all memory-enable inputs and write-enable input are low. While the write-enable input is low, the output is off.

Read Cycle: The stored information (complement of information applied at the data input during the write cycle) is available at the output when the write-enable input is high and the three memory-enable inputs are low. When any one of the memory enable inputs is high, the output will be off.

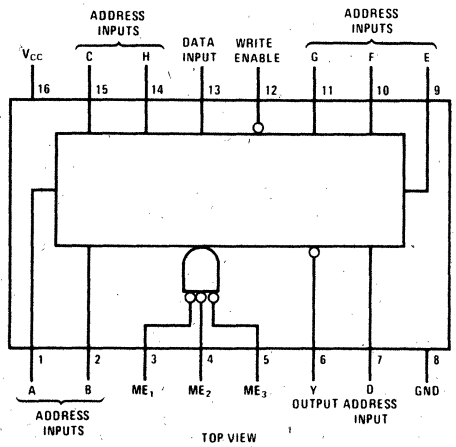
features

- Schottky-clamped for high-speed memory systems:
  - Access from memory-enable inputs 17 ns typ
  - Access from address inputs 35 ns typ
  - Power dissipation 1.4 mW/bit typ
- Open-collector output for word expansion
- Fully decoded, organized as 256 words of one bit each
- Compatible with most TTL and DTL logic circuits
- Multiple memory-enable inputs to minimize external decoding

block and connection diagrams



Dual-In-Line and Flat Package



Order Number DM54S206J or DM74S206J
See Package 10

Order Number DM74S206N
See Package 15

Order Number DM54S206W or DM74S206W
See Package 28

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absolute maximum ratings (Note 1)

Supply Voltage, V_{CC}	7.0V
Input Voltage	5.5V
Output Voltage	5.5V
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
DM54S206	4.5	5.5	V
DM74S206	4.75	5.25	V
Temperature (T_A)			
DM54S206	−55	+125	°C
DM74S206	0	+70	°C

operating conditions

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Low Level Output Current (I_{OL})				16	mA
Width of Write Enable Pulse (t_W)					
DM54S206		50			ns
DM74S206		40			ns
Setup Time (t_{SETUP})					
Address to Write Enable		0			ns
Data to Write Enable		0			ns
Memory Enable to Write Enable		0			ns
Hold Time (t_{HOLD})					
Address from Write Enable		10			ns
Data from Write Enable		10			ns
Memory Enable from Write Enable		0			ns

electrical characteristics (Note 2)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
High-Level Input Voltage (V_{IH})		2			V
Low-Level Input Voltage (V_{IL})				0.8	V
Input clamp voltage	V_{CC} = Min, I_I = −18 mA			−1.2	V
High-Level Output Current (I_{OH})	V_{CC} = Min, V_{IH} = 2V, V_{IL} = 0.8V				
	V_{OH} = 2.4V			40	μA
	V_{OH} = 5.5V			100	μA
Low-Level Output Voltage (V_{OL}) DM54S206 / DM74S206	V_{CC} = Min, V_{IH} = 2V, V_{IL} = 0.8V, I_{OL} = Max			0.5 / 0.45	V
Input Current at Maximum Input Voltage (I_I)	V_{CC} = Max, V_I = 5.5V			1	mA
High-Level Input Current (I_{IH})	V_{CC} = Max, V_I = 2.7V			25	μA
Low-Level Input Current (I_{IL})	V_{CC} = Max, V_I = 0.5V			−250	μA
Supply Current (I_{CC})	V_{CC} = Max, Note 2		70	130	mA

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switching characteristics

All typical values are at V_{CC} = 5.0V, T_A = 25°C. (Note 2)

PARAMETER	CONDITIONS	LIMITS						UNITS
		DM54S206			DM74S206			
		MIN	TYP	MAX	MIN	TYP	MAX	
Access Times from Address (t_{PLH})	C_L = 30 pF, R_L = 300Ω		38	80		38	60	ns
Access Times from Address (t_{PHL})			32	80		32	60	ns
Disable Time from Memory Enable (t_{PLH})			21	45		21	35	ns
Enable Time from Memory Enable (t_{PHL})			13	35		13	25	ns
Disable Time from Write Enable (t_{PLH})			20	50		20	40	ns
Sense-Recovery Time (t_{SR})			14	50		14	40	ns

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: Unless otherwise specified min/max limits apply across the −55°C to +125°C temperature range for DM54S206 and across the 0°C to +70°C range for the DM74S206. All typicals are given for V_{CC} = 5.0V and T_A = +25°C.

Note 3: All voltage values are with respect to network ground terminal.

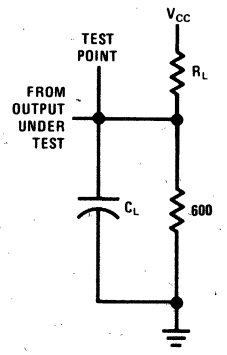
Note 4: I_{CC} is measured with the write enable and memory enable inputs grounded, all other inputs at 4.5V, and the output open.

truth table

FUNCTION	INPUTS		OUTPUT
	MEMORY ENABLE†	WRITE ENABLE	
Write (Store Complement of Data)	L	L	H
Read	L	H	Stored Data
Inhibit	H	X	H

H = high level, L = low level, X = irrelevant
†For memory enable: L = all ME inputs low; H = one or more ME inputs high.

ac test circuit



C_L includes probe and jig capacitance.

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Preliminary

DM93415, DM93415A TTL 1024 × 1-bit fully decoded random access memories

general description

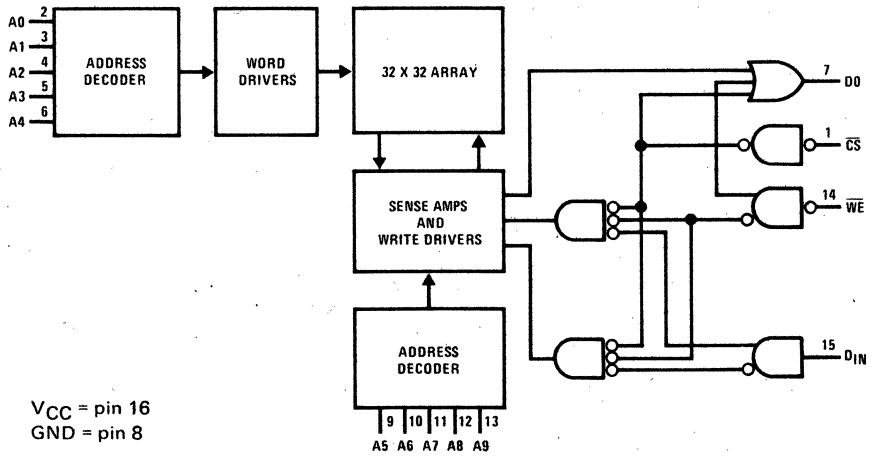
The DM93415 and DM93415A are 1024-bit read/write Random Access Memories organized 1024 words by 1-bit. They are designed for buffer control storage and high performance main memory applications. The devices have typical access times of 40 ns for the DM93415 and 30 ns for the DM93415A.

The DM93415 and DM93415A include full decoding on-chip, separate data input and data output lines and an active low chip select. They are fully compatible with standard DTL and TTL logic families and have an uncommitted collector output for ease of memory expansion.

features

- Uncommitted collector output
- TTL inputs and output
- Non-inverting data output
- Organized 1024 words by 1-bit
- Typical read access time
  - DM93415A commercial—30 ns
  - DM93415 commercial—40 ns
  - DM93415 military—40 ns
- Chip select access time—15 ns typ
- Power dissipation—0.5 mW/bit typ
- Power dissipation decreases with increasing temperature

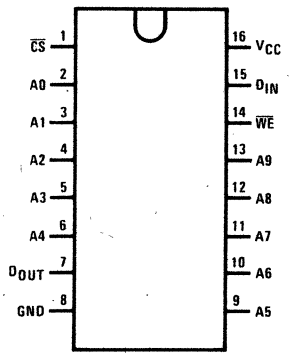
logic diagram



V_{CC} = pin 16
GND = pin 8

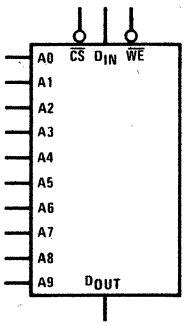
connection diagram

Dual-In-Line and Flat Package



TOP VIEW

logic symbol



Pin Description

$\overline{CS}$	Chip Select
A0—A9	Address Inputs
$\overline{WE}$	Write Enable
D_{IN}	Data Input
D_{OUT}	Data Output

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Preliminary

DM93425, DM93425A TTL 1024 × 1-bit fully decoded random access memories

general description

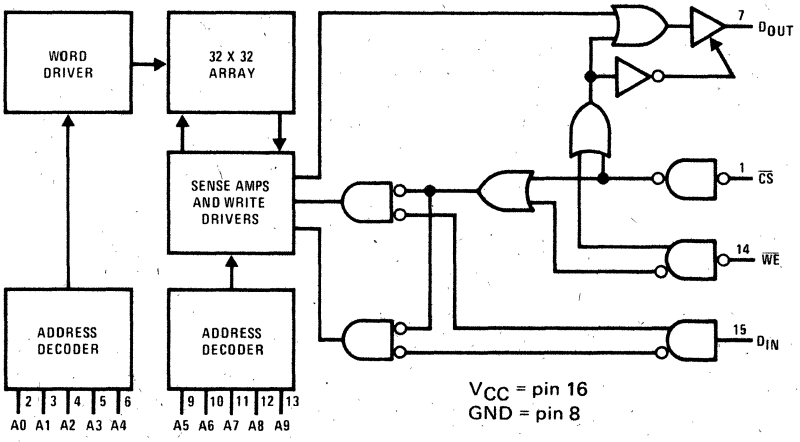
The DM93425 and DM93425A are 1024-bit read/write Random Access Memories organized 1024 words by 1-bit. They are designed for buffer control storage and high performance main memory applications. The devices have typical address access times of 40 ns for the DM93425 and 30 ns for the DM93425A.

The DM93425 and DM93425A include full decoding on-chip, separate data input and data output lines and an active low chip select and write enable. They are fully compatible with standard DTL and TTL logic families. A TRI-STATE® output is provided to drive bus organized systems and/or highly capacitive loads.

features

- TRI-STATE output
- Organized 1024 words by 1-bit
- TTL inputs and output—full 16 mA drive capability
- Typical read access time
  - DM93425A commercial—30 ns
  - DM93425 commercial—40 ns
  - DM93425 military—40 ns
- Chip select access time—15 ns typ
- Non-inverting data output
- Power dissipation—0.5 mW/bit typ
- Power dissipation decreases with increasing temperature

logic diagram



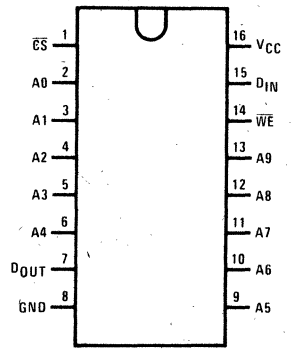
V_{CC} = pin 16
GND = pin 8

Pin Description

$\overline{CS}$	Chip Select
A0–A9	Address Inputs
$\overline{WE}$	Write Enable
D_{IN}	Data Input
D_{OUT}	Data Output

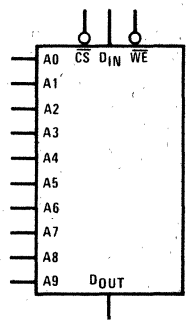
connection diagram

Dual-In-Line and Flat Package



TOP VIEW

logic symbol



National Semiconductor

MEMORY

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MOS RAMs

MM2101, MM2101-1, MM2101-2 1024-bit (256 × 4) static MOS RAM with separate I/O

general description

The National MM2101 is a 256 word by 4 bit static random access memory element fabricated using N-Channel enhancement mode Silicon Gate technology. Static storage cells eliminate the need for refresh and the additional peripheral circuitry associated with refresh. The data is read out nondestructively and has the same polarity as the input data.

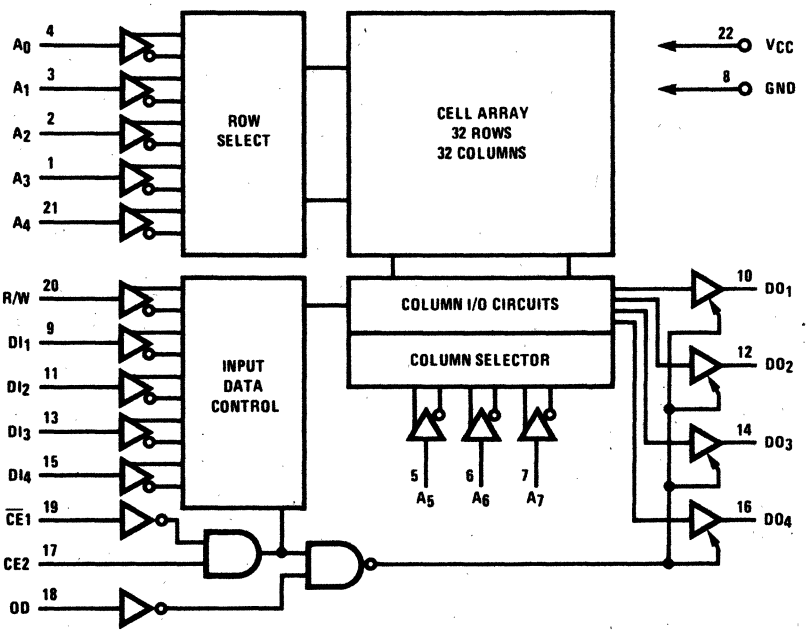
The 2101 is directly TTL compatible in all respects: inputs, outputs, and a single +5 V supply. Two chip-enables allow easy selection of an individual package when outputs are OR-tied. An output disable is provided so that data inputs and outputs can be tied for common I/O systems. The features of this memory device can be combined to make a low cost, high performance, and easy to manufacture memory system.

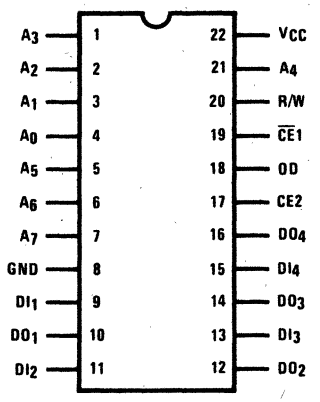
National's silicon gate technology also provides protection against contamination, and permits the use of low cost Epoxy B packaging.

features

- Organization 256 Words by 4 Bits
- Access Time — 0.5 to 1.0 μs Max.
- Single +5 V Supply Voltage
- Directly TTL Compatible — All Inputs and Outputs
- Static MOS — No Clocks or Refreshing Required
- Simple Memory Expansion — Chip Enable Input
- Low Cost Packaging — 22 Pin Epoxy B Dual-In-Line Configuration
- Low Power — Typically 150 mW
- Tri-State ® Output — OR-Tie Capability
- Output Disable Provided for Ease of Use in Common Data Bus Systems

block and connection diagrams





PIN NAMES

DI_1 - DI_4	DATA INPUT
A_0 - A_7	ADDRESS INPUTS
R/W	READ/WRITE INPUT
$\overline{CE}1$, CE2	CHIP ENABLE
OD	OUTPUT DISABLE
DO_1 - DO_4	DATA OUTPUT
V_{CC}	POWER (+5 V)

Order Number MM2101D, MM2101-1D or MM2101-2D
See Package 5

Order Number MM2101-N, MM2101-1N or MM2101-2N
See Package 17

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absolute maximum ratings

Ambient Temperature Under Bias	0°C to +70°C
Storage Temperature	-65°C to +150°C
Voltage on Any Pin With Respect to Ground	-0.5 V to +7 V
Power Dissipation	1 Watt

dc electrical characteristics $T_A = 0°C$ to $+70°C$, $V_{CC} = 5\ V \pm 5\%$ unless otherwise specified.

Symbol	Parameter	Min.	Typ.[1]	Max.	Unit	Test Conditions
I_{LI}	Input Current			10	μA	$V_{IN} = 0$ to 5.25 V
I_{LOH}	I/O Leakage Current[2]			15	μA	$\overline{CE}1 = 2.2\ V$, $V_{OUT} = 4.0\ V$
I_{LOL}	I/O Leakage Current[2]			-50	μA	$\overline{CE}1 = 2.2\ V$, $V_{OUT} = 0.45\ V$
I_{CC1}	Power Supply Current		30	60	mA	$V_{IN} = 5.25\ V$, $I_O = 0\ mA$, $T_A = 25°C$
I_{CC2}	Power Supply Current			70	mA	$V_{IN} = 5.25\ V$, $I_O = 0\ mA$, $T_A = 0°C$
V_{IL}	Input "Low" Voltage	-0.5		+0.65	V	
V_{IH}	Input "High" Voltage	2.2		V_{CC}	V	
V_{OL}	Output "Low" Voltage			+0.45	V	$I_{OL} = 2.0\ mA$
V_{OH}	Output "High" Voltage	2.2			V	$I_{OH} = -150\ \mu A$

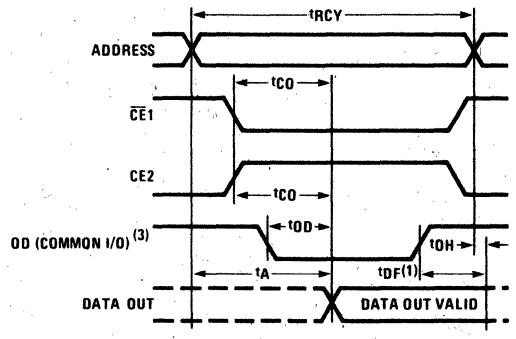
Note 1: Typical values are for $T_A = 25°C$ and nominal supply voltage.
Note 2: Input and Output tied together.

capacitance $T_A = 25°C$, f = 1 MHz

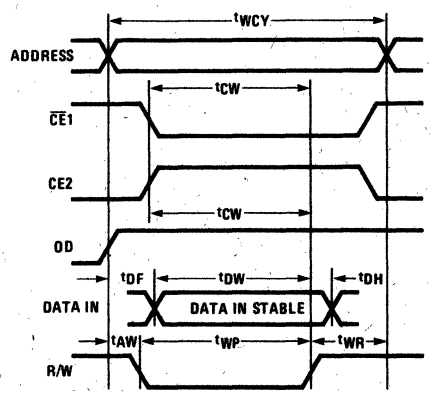
Symbol	Test	Limits (pF)	
		Typ.	Max.
C_{IN}	Input Capacitance (All Input Pins) $V_{IN} = 0\ V$	4	8
C_{OUT}	Output Capacitance $V_{OUT} = 0\ V$	8	12

switching time waveforms

READ CYCLE (R/W = "1")



WRITE CYCLE[2]



Note 1: t_{DF} is with respect to the trailing edge of $\overline{CE}1$, CE2, or OD, whichever occurs first.
Note 2: During the write cycle, OD is a logical 1 for common I/O and "don't care" for separate I/O operation.
Note 3: OD should be tied low for separate I/O operation.

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ac electrical characteristics $T_A = 0°C$ to $+70°C$, $V_{CC} = 5\ V \pm 5\%$, unless otherwise specified.

MM2101

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
READ CYCLE						
t_{RCY}	Read Cycle	1,000			ns	Input Pulse Levels: +0.65 to +2.2 V
t_A	Access Time			1,000	ns	Input Pulse Rise and Fall Times:
t_{CO}	Chip Enable to Output			800	ns	20 ns
t_{OD}	Output Disable to Output			700	ns	Timing Measurement Reference
t_{DF}[1]	Data Output to High Z State	0		200	ns	Level: 1.5 V
t_{OH}	Previous Data Read Valid after change of Address	0			ns	Output Load: 1 TTL Gate and $C_L = 100\ pF$
WRITE CYCLE						
t_{WCY}	Write Cycle	1,000			ns	Input Pulse Levels: +0.65 to +2.2 V
t_{AW}	Write Delay	150			ns	Input Pulse Rise and Fall Times:
t_{CW}	Chip Enable to Write	900			ns	20 ns
t_{DW}	Data Setup	700			ns	Timing Measurement Reference
t_{DH}	Data Hold	100			ns	Level: 1.5 V
t_{WP}	Write Pulse	750			ns	Output Load: 1 TTL Gate and
t_{WR}	Write Recovery	50			ns	$C_L = 100\ pF$

MM2101-1 (500 ns Access Time)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
READ CYCLE						
t_{RCY}	Read Cycle	500			ns	Input Pulse Levels: +0.65 to +2.2 V
t_A	Access Time			500	ns	Input Pulse Rise and Fall Times:
t_{CO}	Chip Enable to Output			350	ns	20 ns
t_{OD}	Output Disable to Output			300	ns	Timing Measurement Reference
t_{DF}[1]	Data Output to High Z State	0		150	ns	Level: 1.5 V
t_{OH}	Previous Data Read Valid after change of Address	0			ns	Output Load: 1 TTL Gate and $C_L = 100\ pF$
WRITE CYCLE						
t_{WCY}	Write Cycle	500			ns	Input Pulse Levels: +0.65 to +2.2 V
t_{AW}	Write Delay	100			ns	Input Pulse Rise and Fall Times:
t_{CW}	Chip Enable to Write	400			ns	20 ns
t_{DW}	Data Setup	280			ns	Timing Measurement Reference
t_{DH}	Data Hold	100			ns	Level: 1.5 V
t_{WP}	Write Pulse	300			ns	Output Load: 1 TTL Gate and
t_{WR}	Write Recovery	50			ns	$C_L = 100\ pF$

MM2101-2 (650 ns Access Time)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
READ CYCLE						
t_{RCY}	Read Cycle	650			ns	Input Pulse Levels: +0.65 to +2.2 V
t_A	Access Time			650	ns	Input Pulse Rise and Fall Times:
t_{CO}	Chip Enable to Output			400	ns	20 ns
t_{OD}	Output Disable to Output			350	ns	Timing Measurement Reference
t_{DF}[1]	Data Output to High Z State	0		150	ns	Level: 1.5 V
t_{OH}	Previous Data Read Valid after change of Address	0			ns	Output Load: 1 TTL Gate and $C_L = 100\ pF$
WRITE CYCLE						
t_{WCY}	Write Cycle	650			ns	Input Pulse Levels: +0.65 to +2.2 V
t_{AW}	Write Delay	150			ns	Input Pulse Rise and Fall Times:
t_{CW}	Chip Enable to Write	550			ns	20 ns
t_{DW}	Data Setup	400			ns	Timing Measurement Reference
t_{DH}	Data Hold	100			ns	Level: 1.5 V
t_{WP}	Write Pulse	400			ns	Output Load: 1 TTL Gate and
t_{WR}	Write Recovery	50			ns	$C_L = 100\ pF$

Note 1: t_{DF} is with respect to the trailing edge of $\overline{CE}1$, CE2, or OD, whichever occurs first.

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MOS RAMs

MM2102, MM2102-1, MM2102-2
1024-bit fully decoded static random access memories

general description

The MM2102 family of 1024 word by one bit static random access read write memories are manufactured using N-channel enhancement mode silicon gate technology. Static storage cells eliminate the need for clocks and refresh. Data in and data out have the same polarity and the read operation is nondestructive.

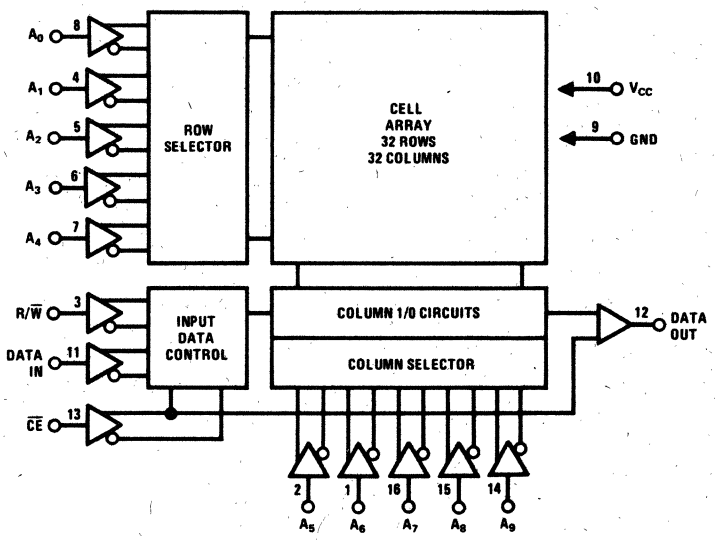
Low threshold silicon gate N-channel technology allows complete DTL/TTL compatibility of all inputs and outputs as well as a single +5V supply. The separate chip enable input ($\overline{CE}$) controlling the TRI-STATE® output allows easy memory expansion by OR-tying individual devices to a data bus.

The simple interface and high performance make the MM2102 family ideally suited for those applications, for large and small storage capacity, where cost is an important design consideration.

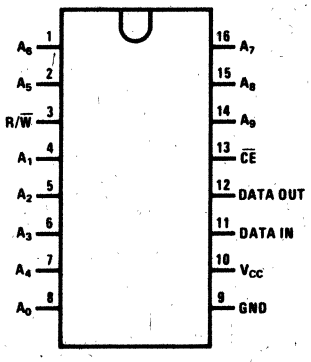
features

- Single +5V supply
- All inputs and output directly DTL/TTL compatible
- Static operation—no clocks or refreshing required
- Low power 150 mW typ
- Fast access
  - MM2102 1μs
  - MM2102-1 500 ns
  - MM2102-2 650 ns
- TRI-STATE output for bus interface
- Chip enable allows simple memory expansion
- On chip address decode
- All inputs protected against static discharge
- Low cost 16-pin Epoxy B package

block and connection diagrams



Dual-In-Line Package



TOP VIEW

Order Number MM2102D, MM2102-1D or MM2102-2D
See Package 3

Order Number MM2102N, MM2102-1N or MM2102-2N
See Package 15

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absolute maximum ratings (Note 1)

Voltage at Any Pin	−0.5V to +7.0V
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Power Dissipation	1W
Lead Temperature (Soldering, 10 seconds)	300°C

dc electrical characteristics

(T_A within operating temperature range, V_{CC} = 5V ±5%, unless otherwise noted.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Logical "1" Input Voltage (V_{IH})		2.2		V_{CC}	V
Logical "0" Input Voltage (V_{IL})		−0.5		0.65	V
Logical "1" Output Voltage (V_{OH})	I_{OH} = −100μA	2.2			V
Logical "0" Output Voltage (V_{OL})	I_{OL} = 1.9 mA			0.45	V
Input Load Current (I_{LI})	V_{IN} = 0 to 5.25V			10	μA
Output Leakage Current (I_{LOH})	$\overline{CE}$ = 2.2V, V_{OUT} = 4.0V			10	μA
Output Leakage Current (I_{LOL})	$\overline{CE}$ = 2.2V, V_{OUT} = 0.45V			−100	μA
Power Supply Current (I_{CC1})	All Inputs = 5.25V, Data Out Open, T_A = 25°C		30	60	mA
Power Supply Current (I_{CC2})	All Inputs = 5.25V, Data Out Open, T_A = 0°C			70	mA

ac electrical characteristics

(T_A within operating temperature range, V_{CC} = 5V ±5%, unless otherwise specified.)
See ac test circuit and switching time waveforms.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ CYCLE					
Read Cycle (t_{RC})					
MM2102	R/$\overline{W}$ = V_{IH}	1000			ns
MM2102-1	R/$\overline{W}$ = V_{IH}	500			ns
MM2102-2	R/$\overline{W}$ = V_{IH}	650			ns
Access Time (t_A)					
MM2102				1000	ns
MM2102-1				500	ns
MM2102-2				650	ns
Chip Enable to Output Time (t_{CO})					
MM2102				500	ns
MM2102-1				350	ns
MM2102-2				400	ns
Previous Read Data Valid with Respect to Address (t_{OH1})		50			ns
Previous Read Data Valid with Respect to Chip, Enable (t_{OH2})		0			ns

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ac electrical characteristics (con't)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
WRITE CYCLE					
Write Cycle (t_{WC})					
MM2102		1000			ns
MM2102-1		500			ns
MM2102-2		650			ns
Address to Write Set-up Time (t_{AW})					
MM2102		200			ns
MM2102-1		150			ns
MM2102-2		200			ns
Write Pulse Width (t_{WP})					
MM2102		750			ns
MM2102-1		300			ns
MM2102-2		400			ns
Write Recovery Time (t_{WR})		50			ns
Data Set-up Time (t_{DW})					
MM2102		800			ns
MM2102-1		330			ns
MM2102-2		450			ns
Data Hold Time (t_{DH})		100			ns
Chip Enable to Write Set-up Time (t_{CW})					
MM2102		900			ns
MM2102-1		400			ns
MM2102-2		550			ns
CAPACITANCE					
Input Capacitance (All Inputs) (C_{IN}) (Note 4)	V_{IN} = 0V, T_A = 25°C, f = 1.0 MHz (Note 2)		3.0	5.0	pF
Output Capacitance (C_{OUT}) (Note 4)	V_{OUT} = 0V, T_A = 25°C, f = 1.0 MHz (Note 2)		7.0	10.0	pF

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

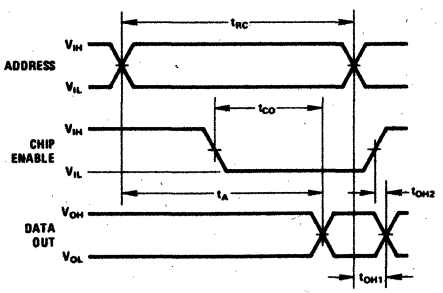
Note 2: Capacitance is guaranteed by periodic testing.

Note 3: Positive true logic notation is used: Logical "1" = most positive voltage level, Logical "0" = most negative voltage level.

Note 4: Typical values are for T_A = 25°C and nominal supply voltage.

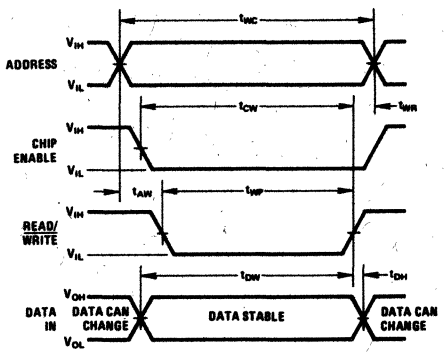
switching time waveforms

Read Cycle



Note: All times measured with respect to 1.5V level with t_r and $t_f \leq 20$ ns.

Write Cycle



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MM2102A, MM2102AL family
1024-bit (1024 × 1) static random access memories

general description

The MM2102A family of high speed 1024 x 1-bit static random access read/write memories are manufactured using N-channel depletion-mode silicon gate technology. Static storage cells eliminate the need for clocks or refresh circuitry and the resultant cost associated with them.

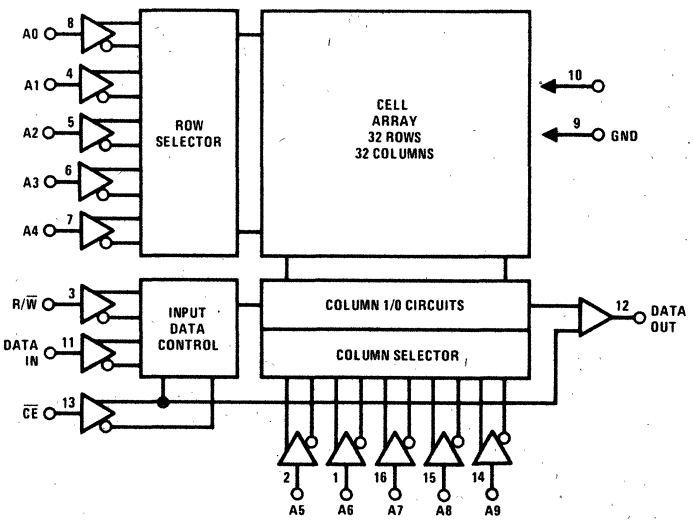
Low threshold silicon gate N-channel technology allows complete DTL/TTL compatibility of all inputs and outputs as well as a single 5V supply. The separate chip enable input ($\overline{CE}$) controlling the TRI-STATE® output allows easy memory expansion by OR-tying individual devices to a data bus. Data in and data out have the same polarity.

In addition to the MM2102A, a low power version, the MM2102AL, is also available. This selection offers a maximum operating current of 33 mA and a guaranteed standby mode down to a power supply voltage of 1.5V.

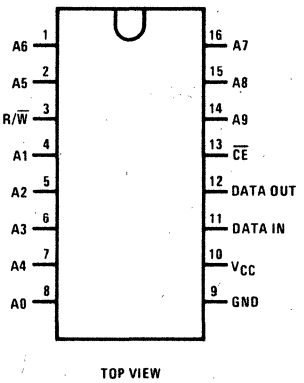
features

- Single 5V supply
- All inputs and outputs directly DTL/TTL compatible
- Static operation—no clocks or refresh
- TRI-STATE output for bus interface
- All inputs protected against static charge
- Access time down to 250 ns

block diagram

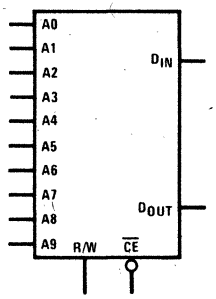


connection diagram



TOP VIEW

logic symbol



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absolute maximum ratings (Note 1)

Voltage at Any Pin	−0.5V to +7V
Voltage at Any Pin	−0.5V to +7V
Storage Temperature	−65°C to +150°C
Power Dissipation	1W
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})	4.75	5.25	V
Ambient Temperature (T_A)	0	+70	°C
Input Low Voltage	−0.5	0.8	V
Input High Voltage	2.0	V_{CC}	V

dc electrical characteristics $T_A = 0°C$ to $+70°C$, $V_{CC} = \pm5\%$, unless otherwise specified.

SYMBOL	PARAMETER	CONDITION	MM2102A, MM2102A-2, MM2102A-4		MM2102AL, MM2102A-2L, MM2102A-4L		UNITS
			MIN	MAX	MIN	MAX	
I_{LI}	Input Load Current	V_{IN} = 0 to 5.25V		10		10	μA
I_{LOH}	Output Leakage Current	$\overline{CE}$ = 2V, V_{OUT} = 2.4V		5		5	μA
I_{LOL}	Output Leakage Current	$\overline{CE}$ = 2V, V_{OUT} = 0.4V		−10		−10	μA
I_{CC}	Power Supply Current	All Inputs = 5.25V, Data Output Open, T_A = 25°C		50		31	mA
I_{CC}	Power Supply Current	All Inputs = 5.25V, Data Output Open, T_A = 0°C		55		33	mA
V_{OL}	Output Low Voltage	I_{OL} = 3.2 mA		0.4		0.4	V
V_{OH}	Output High Voltage	I_{OH} = −200 μA	2.4		2.4		V

Note 1: "Absolute Maximum Ratings" are those values beyond which the device may be permanently damaged. They do not mean the device may be operated at these values.

ac electrical characteristics (With standard load) $T_A = 0°C$ to $+70°C$, $V_{CC} = 5V \pm5\%$ unless otherwise specified.

SYMBOL	PARAMETER	MM2102A-2, MM2102A-2L		MM2102A, MM2102AL		MM2102A-4, MM2102A-4L		MM2102A-6, MM2102A-6L		UNITS
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
READ CYCLE *(Figure 1)*										
t_{RC}	Read Cycle	250		350		450		650		ns
t_A	Access Time		250		350		450		650	ns
t_{CO}	Chip Enable to Output Time		100		150		200		200	ns
t_{OH1}	Previous Read Data Valid with Respect to Address	40		40		40		50		ns
t_{OH2}	Previous Read Data Valid with Respect to Chip Enable	0		0		0		0		ns

ac electrical characteristics (With standard load) $T_A = 0°C$ to $+70°C$, $V_{CC} = 5V \pm5\%$ unless otherwise specified.

SYMBOL	PARAMETER	MM2102A-2, MM2102A-2L		MM2102A, MM2102AL		MM2102A-4, MM2102A-4L		MM2102A-6, MM2102A-6L		UNITS
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
WRITE CYCLE *(Figure 2)*										
t_{WC}	Write Cycle	250		350		450		650		ns
t_{AW}	Address to Write Set-Up	20		20		20		20		ns
t_{WP}	Write Pulse Width	100		150		200		200		ns
t_{WR}	Write Recovery Time	0		0		0		0		ns
t_{DW}	Date Set-Up Time	85		125		175		175		ns
t_{DH}	Data Hold Time	0		0		0		0		ns
t_{CW}	Chip Enable To Write Set-Up	100		150		200		200		ns

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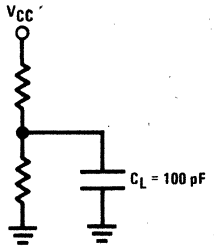
ac electrical characteristics $T_A = 25°C$, f = 1 MHz

SYMBOL	PARAMETER	LIMIT (pF)	
		TYP	MAX
CAPACITANCE [2]			
C_{IN}	Input Capacitance (All Inputs V_{IN} = 0V)	3	5
C_{OUT}	Output Capacitance, V_O = 0V	4	6

ac test circuit



switching time waveforms

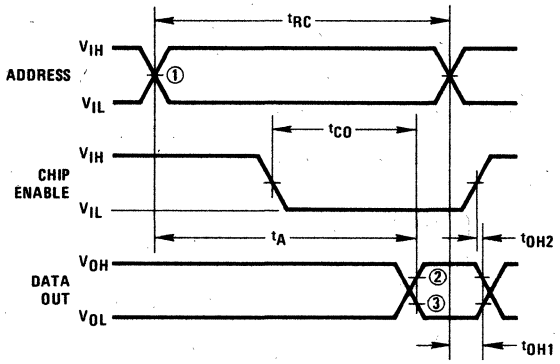


FIGURE 1. Read Cycle

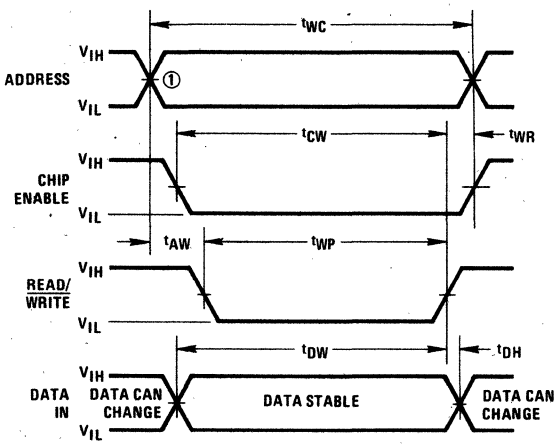


FIGURE 2. Write Cycle

Note ①: Input reference level for timing is 1.5V.
Note ②: V_{OH} = 2V is reference level for output high.
Note ③: V_{OL} = 0.8V is reference level for output low.
Note ④: Input rise and fall times are 10 ns.

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MOS RAMs

MM2102MD, MM2102-2MD military temperature range 1024-bit fully decoded static random access memories

general description

The MM2102 family of 1024 word by one bit static random access read write memories are manufactured using N-channel enhancement mode silicon gate technology. Static storage cells eliminate the need for clocks and refresh. Data in and data out have the same polarity and the read operation is nondestructive.

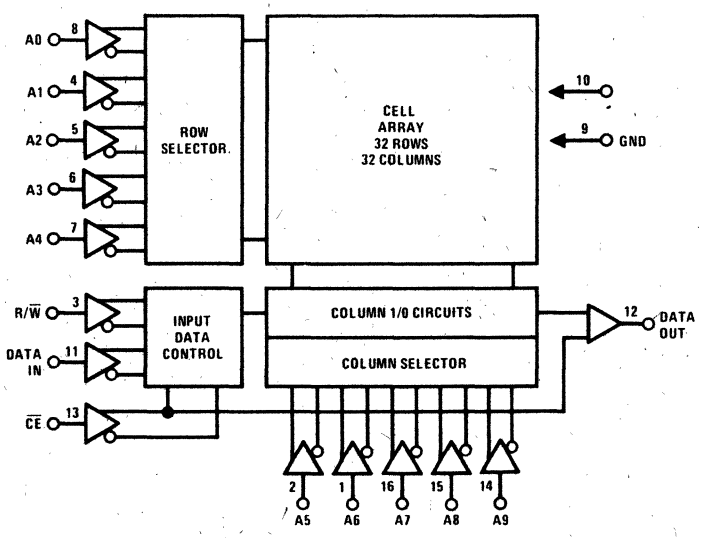
Low threshold silicon gate N-channel technology allows complete DTL/TTL compatibility of all inputs and outputs as well as a single +5V supply. The separate chip enable input ($\overline{CE}$) controlling the TRI-STATE® output allows easy memory expansion by OR-tying individual devices to a data bus.

The simple interface and high performance make the MM2102 family ideally suited for those applications, for large and small storage capacity, where cost is an important design consideration.

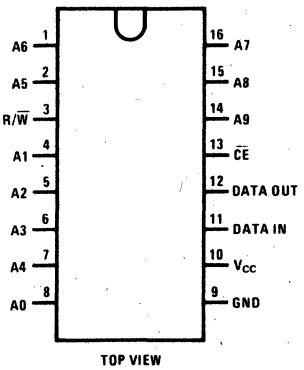
features

- Single +5V supply
- All inputs and output directly DTL/TTL compatible
- Static operation—no clocks or refreshing required
- Low power 150 mW typ
- Fast Access
  - MM2102 1μs
  - MM2102-2 650 ns
- TRI-STATE output for bus interface
- Chip enable allows simple memory expansion
- On chip address decode
- All inputs protected against static discharge
- −55°C to +125°C Operation

block and connection diagrams



Dual-In-Line Package



TOP VIEW

Order Number MM2102MD or MM2102-2MD
See Package 3

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absolute maximum ratings (Note 1)

Voltage at Any Pin	−0.5V to +7.0V
Operating Temperature Range	−55°C to +125°C
Storage Temperature Range	−65°C to +150°C
Power Dissipation	1W
Lead Temperature (Soldering, 10 seconds)	300°C

dc electrical characteristics

(T_A within operating temperature range, V_{CC} = 5V ±10%, unless otherwise noted.)

	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IH}	Logical "1" Input Voltage		2.2		V_{CC}	V
V_{IL}	Logical "0" Input Voltage		−0.5		0.65	V
V_{OH}	Logical "1" Output Voltage	I_{OH} = −100μA	2.2			V
V_{OL}	Logical "0" Output Voltage	I_{OL} = 2.1 mA			0.45	V
I_{LI}	Input Load Current	V_{IN} = 0 to 5.5V			10	μA
I_{LOH}	Output Leakage Current	$\overline{CE}$ = 2.2V, V_{OUT} = 4.0V			10	μA
I_{LOL}	Output Leakage Current	$\overline{CE}$ = 2.2V, V_{OUT} = 0.45V			−50	μA
I_{CC1}	Power Supply Current	All Inputs = 5.5V, Data Out Open, T_A = 25°C, (Note 4)		25	45	mA
I_{CC2}	Power Supply Current	All Inputs = 5.5V, Data Out Open, T_A = −55°C to +125°C			55	mA

ac electrical characteristics

(T_A within operating temperature range, V_{CC} = 5V ±10%, unless otherwise specified.)
See ac test circuit and switching time waveforms.

	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ CYCLE						
t_{RC}	Read Cycle					
	MM2102	$R/\overline{W}$ = V_{IH}	1000			ns
	MM2102-2	$R/\overline{W}$ = V_{IH}	650			ns
t_A	Access Time					
	MM2102				1000	ns
	MM2102-2				650	ns
t_{CO}	Chip Enable to Output Time					
	MM2102				500	ns
	MM2102-2				400	ns
t_{OH1}	Previous Read Data Valid with Respect to Address		50			ns
t_{OH2}	Previous Read Data Valid with Respect to Chip, Enable		0			ns

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ac electrical characteristics (con't)

PARAMETER		CONDITIONS	MIN	TYP	MAX	UNITS
WRITE CYCLE						
t_{WC}	Write Cycle					
	MM2102		1000			ns
	MM2102-2		650			ns
t_{AW}	Address to Write Set-Up Time					
	MM2102		200			ns
	MM2102-2		200			ns
t_{WP}	Write Pulse Width					
	MM2102		750			ns
	MM2102-2		400			ns
t_{WR}	Write Recovery Time		50			ns
t_{DW}	Data Set-Up Time					
	MM2102		800			ns
	MM2102-2		450			ns
t_{DH}	Data Hold Time		100			ns
t_{CW}	Chip Enable to Write Set-Up Time					
	MM2102		900			ns
	MM2102-2		550			ns
CAPACITANCE						
C_{IN}	Input Capacitance (All Inputs)	V_{IN} = 0V, T_A = 25°C, f = 1.0 MHz (Notes 2 and 4)		3	5	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0V, T_A = 25°C, f = 1.0 MHz (Notes 2 and 4)		7	10	pF

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

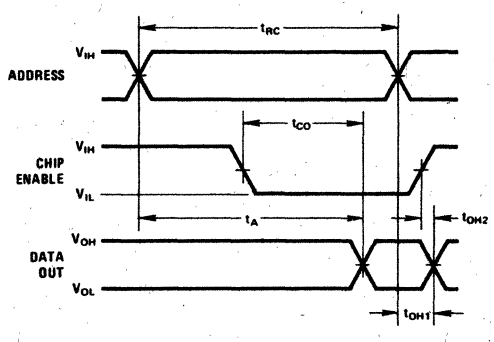
Note 2: Capacitance is guaranteed by periodic testing.

Note 3: Positive true logic notation is used: Logical "1" = most positive voltage level, Logical "0" = most negative voltage level.

Note 4: Typical values are for T_A = 25°C and nominal supply voltage.

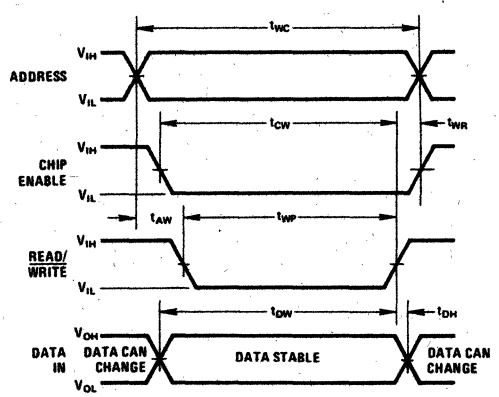
switching time waveforms

Read Cycle



Note: All times measured with respect to 1.5V level with t_r and $t_f \leq 20$ ns.

Write Cycle



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MM2111, MM2111-1, MM2111-2 1024-bit (256 × 4) static MOS RAM with common I/O and output disable

general description

The National MM2111 is a 256 by 4 static random access memory element fabricated using N-channel enhancement mode Silicon Gate technology. Static storage cells eliminate the need for refresh and the peripheral circuitry associated with refresh. The data is read out nondestructively and has the same polarity as the input data. Common Data Input/Output pins are provided.

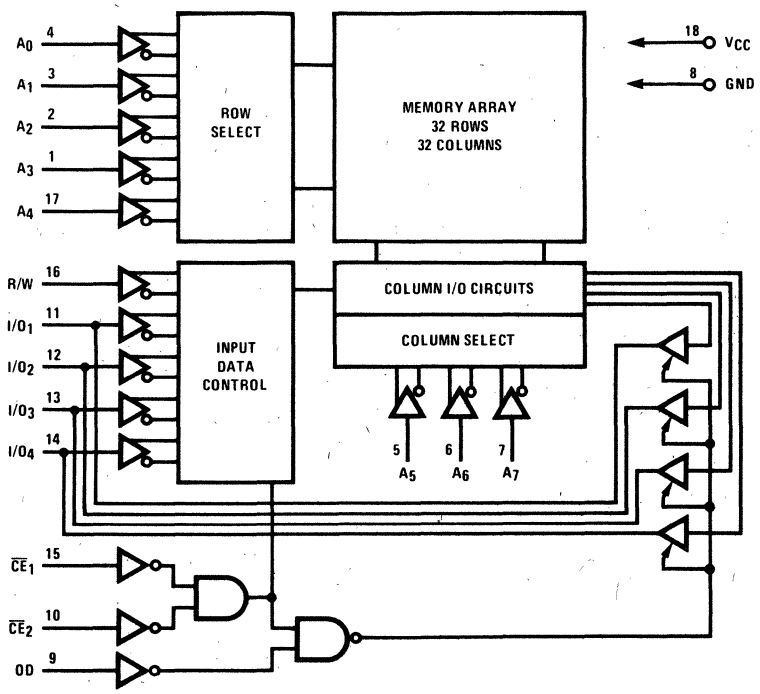
The 2111 is directly TTL in all respects: inputs, outputs and a single +5 V supply. The two Chip-enables allow easy selection of an individual package when outputs are OR-tied. The features of this memory device can be combined to make a low cost, high performance, and easy to manufacture memory system.

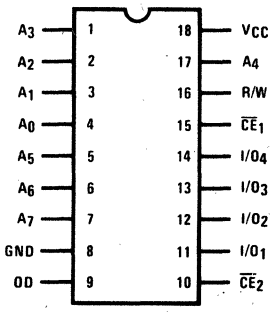
National's silicon gate technology provides excellent protection against contamination and permits the use of low cost Epoxy B packaging.

features

- Organization 256 Words by 4 Bits
- Common Data Input and Output
- Single +5 V Supply Voltage
- Directly TTL Compatible — All Inputs and Outputs
- Static MOS — No Clocks or Refreshing Required
- Access Time — 0.5 to 1.0 μs Max.
- Simple Memory Expansion — Chip Enable Input
- Low Cost Packaging — 18 Pin Epoxy B Dual-In-Line Configuration
- Low Power — Typically 150 mW
- Tri-State ® Output — OR-Tie Capability

block and connection diagrams





PIN NAMES

A_0-A_7	ADDRESS INPUTS
OD	OUTPUT DISABLE
R/W	READ/WRITE INPUT
$\overline{CE}1$	CHIP ENABLE 1
$\overline{CE}2$	CHIP ENABLE 2
I/O_1-I/O_4	DATA INPUT/OUTPUT

Order Number MM2111D, MM2111-1D or MM2111-2D
See Package 4

Order Number MM2111N, MM2111-1N or MM2111-2N
See Package 16

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absolute maximum ratings

Ambient Temperature Under Bias	0°C to +70°C
Storage Temperature	-65°C to +150°C
Voltage On Any Pin With Respect to Ground	-0.5 V to +7 V
Power Dissipation	1 Watt

dc electrical characteristics $T_A = 0°C$ to $+70°C$, $V_{CC} = 5\ V \pm 5\%$, unless otherwise specified.

Symbol	Parameter	Min.	Typ.[1]	Max.	Unit	Test Conditions
I_{LI}	Input Current			10	μA	$V_{IN} = 0$ to 5.25 V
I_{LOH}	I/O Leakage Current[2]			15	μA	$\overline{CE} = 2.2\ V$, $V_{I/O} = 4.0\ V$
I_{LOL}	I/O Leakage Current[2]			-50	μA	$\overline{CE} = 2.2\ V$, $V_{I/O} = 0.45\ V$
I_{CC1}	Power Supply Current		30	60	mA	$V_{IN} = 5.25\ V$, $I_{I/O} = 0\ mA$, $T_A = 25°C$
I_{CC2}	Power Supply Current			70	mA	$V_{IN} = 5.25\ V$, $I_{I/O} = 0\ mA$, $T_A = 0°C$
V_{IL}	Input "Low" Voltage	-0.5		+0.65	V	
V_{IH}	Input "High" Voltage	2.2		V_{CC}	V	
V_{OL}	Output "Low" Voltage			+0.45	V	$I_{OL} = 2.0\ mA$
V_{OH}	Output "High" Voltage	2.2			V	$I_{OH} = -150\ \mu A$

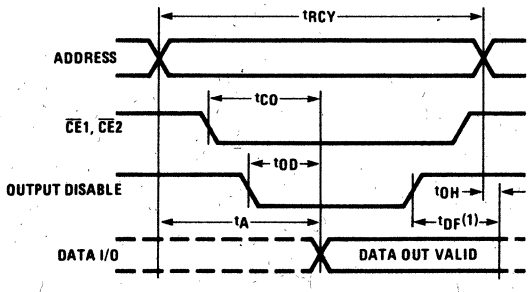
Note 1: Typical values are for $T_A = 25°C$ and nominal supply voltage.

capacitance $T_A = 25°C$, f = 1 MHz

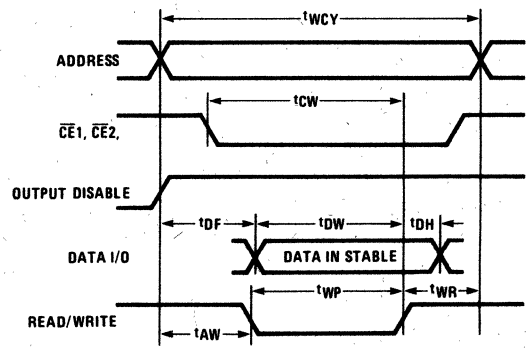
Symbol	Test	Limits (pF)	
		Typ.	Max.
C_{IN}	Input Capacitance (All Input Pins) $V_{IN} = 0\ V$	4	8
$C_{I/O}$	I/O Capacitance $V_{I/O} = 0\ V$	10	15

switching time waveforms

READ CYCLE (R/W = "1")



WRITE CYCLE



Note 1: t_{DF} is with respect to the trailing edge of $\overline{CE}1$, $\overline{CE}2$, or OD, whichever occurs first.

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ac electrical characteristics

$T_A = 0°C$ to $+70°C$, $V_{CC} = 5\ V \pm 5\%$, unless otherwise specified.

MM2111

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
READ CYCLE						
t_{RCY}	Read Cycle	1,000			ns	Input Pulse Levels: +0.65 to +2.2 V
t_A	Access Time			1,000	ns	Input Pulse Rise and Fall Times:
t_{CO}	Chip Enable to Output			800	ns	20 ns
t_{OD}	Output Disable to Output			700	ns	Timing Measurement Reference
t_{DF}[1]	Data Output to High Z State	0		200	ns	Level: 1.5 V
t_{OH}	Previous Data Read Valid after change of Address	0			ns	Output Load: 1 TTL Gate and $C_L = 100\ pF$
WRITE CYCLE						
t_{WCY}	Write Cycle	1,000			ns	Input Pulse Levels: +0.65 to +2.2 V
t_{AW}	Write Delay	150			ns	Input Pulse Rise and Fall Times:
t_{CW}	Chip Enable to Write	900			ns	20 ns
t_{DW}	Data Setup	700			ns	Timing Measurement Reference
t_{DH}	Data Hold	100			ns	Level: 1.5 V
t_{WP}	Write Pulse	750			ns	Output Load: 1 TTL Gate and
t_{WR}	Write Recovery	50			ns	$C_L = 100\ pF$

MM2111-1 (500 ns Access Time)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
READ CYCLE						
t_{RCY}	Read Cycle	500			ns	Input Pulse Levels: +0.65 to +2.2 V
t_A	Access Time			500	ns	Input Pulse Rise and Fall Times:
t_{CO}	Chip Enable to Output			350	ns	20 ns
t_{OD}	Output Disable to Output			300	ns	Timing Measurement Reference
t_{DF}[1]	Data Output to High Z State	0		150	ns	Level: 1.5 V
t_{OH}	Previous Data Read Valid after change of Address	0			ns	Output Load: 1 TTL Gate and $C_L = 100\ pF$
WRITE CYCLE						
t_{WCY}	Write Cycle	500			ns	Input Pulse Levels: +0.65 to +2.2 V
t_{AW}	Write Delay	100			ns	Input Pulse Rise and Fall Times:
t_{CW}	Chip Enable to Write	400			ns	20 ns
t_{DW}	Data Setup	280			ns	Timing Measurement Reference
t_{DH}	Data Hold	100			ns	Level: 1.5 V
t_{WP}	Write Pulse	300			ns	Output Load: 1 TTL Gate and
t_{WR}	Write Recovery	50			ns	$C_L = 100\ pF$

MM2111-2 (650 ns Access Time)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
READ CYCLE						
t_{RCY}	Read Cycle	650			ns	Input Pulse Levels: +0.65 to +2.2 V
t_A	Access Time			650	ns	Input Pulse Rise and Fall Times:
t_{CO}	Chip Enable to Output			400	ns	20 ns
t_{OD}	Output Disable to Output			350	ns	Timing Measurement Reference
t_{DF}[1]	Data Output to High Z State	0		150	ns	Level: 1.5 V
t_{OH}	Previous Data Read Valid after change of Address	0			ns	Output Load: 1 TTL Gate and $C_L = 100\ pF$
WRITE CYCLE						
t_{WCY}	Write Cycle	650			ns	Input Pulse Levels: +0.65 to +2.2 V
t_{AW}	Write Delay	150			ns	Input Pulse Rise and Fall Times:
t_{CW}	Chip Enable to Write	550			ns	20 ns
t_{DW}	Data Setup	400			ns	Timing Measurement Reference
t_{DH}	Data Hold	100			ns	Level: 1.5 V
t_{WP}	Write Pulse	400			ns	Output Load: 1 TTL Gate and
t_{WR}	Write Recovery	50			ns	$C_L = 100\ pF$

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MOS RAMs

MM2112, MM2112-2 1024-bit (256 × 4) static MOS RAM with common data I/O

general description

The National MM2112 is a 256 by 4 static random access memory element fabricated using N-Channel enhancement mode Silicon Gate technology. Static storage cells eliminate the need for refresh and the peripheral circuitry associated with refresh. The data is read out nondestructively and has the same polarity as the input data. Common Data Input/Output pins are provided.

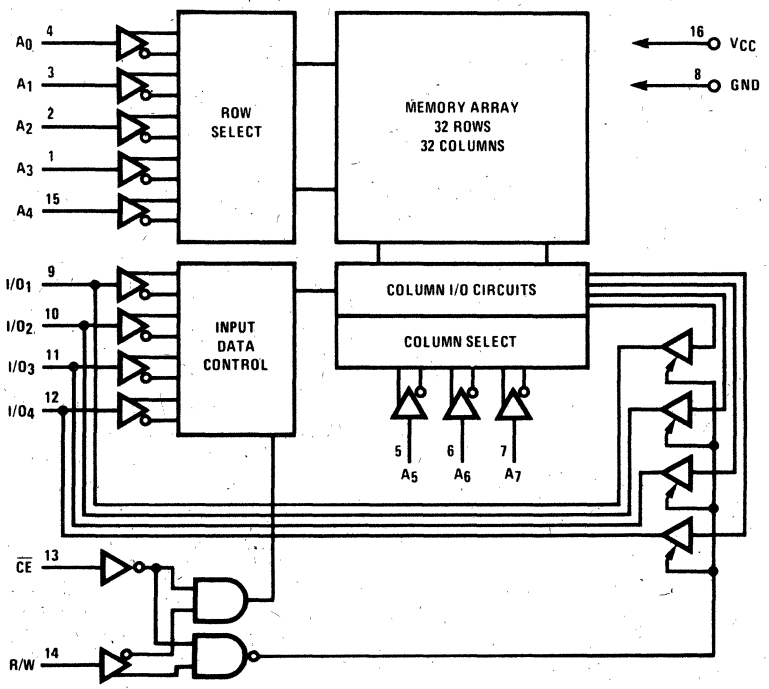
The MM2112 is directly TTL in all respects: inputs, outputs and a single +5 V supply. The Chip-enable allows easy selection of an individual package when outputs are OR-tied. The features of this memory device can be combined to make a low cost, high performance, and easy to manufacture memory system.

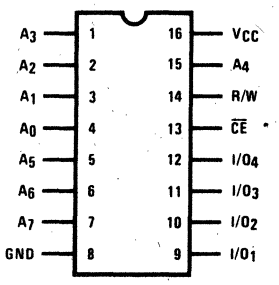
National's silicon gate technology provides excellent protection against contamination and permits the use of low cost Epoxy B packaging.

features

- Organization 256 Words by 4 Bits
- Common Data Input and Output
- Single +5 V Supply Voltage
- Directly TTL Compatible – All Inputs and Outputs
- Static MOS – No Clocks or Refreshing Required
- Access Time – 0.65 to 1 μs Max.
- Simple Memory Expansion – Chip Enable Input
- Low Cost Packaging – 16 Pin Epoxy B Dual-In-Line Configuration
- Low Power – Typically 150 mW
- Tri-State ® Output – OR-Tie Capability

block and connection diagrams





PIN NAMES

A_0-A_7	ADDRESS INPUTS
R/W	READ/WRITE INPUT
$\overline{CE}$	CHIP ENABLE INPUT
I/O_1-I/O_4	DATA INPUT/OUTPUT
V_{CC}	POWER (+5 V)

Order Number MM2112D or MM2112-2D
See Package 3

Order Number MM2112N or MM2112-2N
See Package 15

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absolute maximum ratings

Ambient Temperature Under Bias	0°C to +70°C
Storage Temperature	-65°C to +150°C
Voltage On Any Pin With Respect to Ground	-0.5 V to +7 V
Power Dissipation	1 Watt

dc electrical characteristics

$T_A = 0°C$ to $+70°C$, $V_{CC} = 5\ V \pm 5\%$ unless otherwise specified.

Symbol	Parameter	Min.	Typ.[1]	Max.	Unit	Test Conditions
I_{LI}	Input Current			10	μA	V_{IN} = 0 to 5.25 V
I_{LOH}	I/O Leakage Current			15	μA	$\overline{CE}$ = 2.2 V, $V_{I/O}$ = 4.0 V
I_{LOL}	I/O Leakage Current			-50	μA	$\overline{CE}$ = 2.2 V, $V_{I/O}$ = 0.45 V
I_{CC1}	Power Supply Current		30	60	mA	V_{IN} = 5.25 V, $I_{I/O}$ = 0 mA, $T_A = 25°C$
I_{CC2}	Power Supply Current			70	mA	V_{IN} = 5.25 V, $I_{I/O}$ = 0 mA, $T_A = 0°C$
V_{IL}	Input "Low" Voltage	-0.5		+0.65	V	
V_{IH}	Input "High" Voltage	2.2		V_{CC}	V	
V_{OL}	Output "Low" Voltage			+0.45	V	I_{OL} = 2 mA
V_{OH}	Output "High" Voltage	2.2			V	I_{OH} = -150 μA

Note 1: Typical values are for $T_A = 25°C$ and nominal supply voltage.

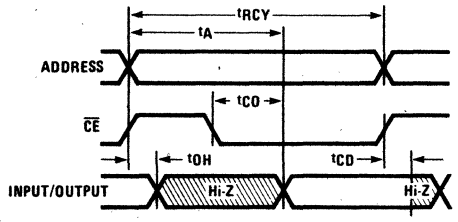
capacitance

$T_A = 25°C$, f = 1 MHz

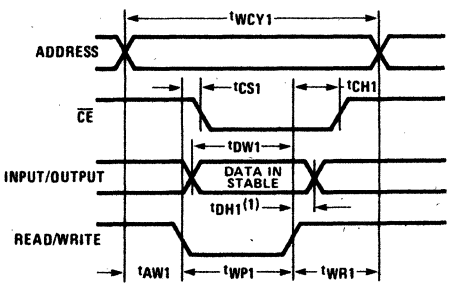
Symbol	Test	Limits (pF)	
		Typ.	Max.
C_{IN}	Input Capacitance (All Input Pins) V_{IN} = 0 V	4	8
$C_{I/O}$	I/O Capacitance $V_{I/O}$ = 0 V	10	18

switching time waveforms

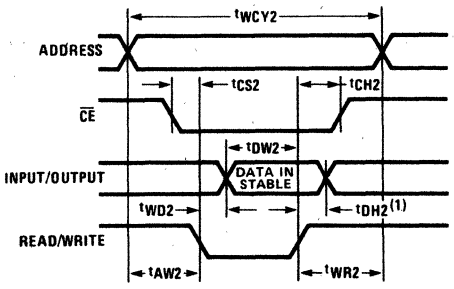
READ CYCLE (R/W = "1")



WRITE CYCLE #1



WRITE CYCLE #2



Note 1: Data Hold Time (T_{OH}) is referenced to the trailing edge of CHIP ENABLE ($\overline{CE}$) or READ/WRITE (R/W) whichever comes first.

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ac electrical characteristics $T_A = 0°C$ to $+70°C$, $V_{CC} = 5\ V \pm 5\%$ unless otherwise specified.

MM2112

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
READ CYCLE						
t_{RCY}	Read Cycle	1,000			ns	Input Pulse Levels: +0.65 to +2.2 V
t_A	Access Time			1,000	ns	Input Pulse Rise and Fall Times: 20 ns
t_{CO}	Chip Enable to Output Time			800	ns	Timing Measurement Reference Level: 1.5 V
t_{CD}	Chip Enable to Output Disable Time	0		200	ns	Output Load: 1 TTL Gate and $C_L = 100$ pF
t_{OH}	Previous Read Data Valid After Change of Address	50			ns	
WRITE CYCLE #1						
t_{WCY1}	Write Cycle	850			ns	
t_{AW1}	Address to Write Setup Time	150			ns	Input Pulse Levels: +0.65 to +2.2 V
t_{DW1}	Write Setup Time	650			ns	Input Pulse Rise and Fall Times: 20 ns
t_{WP1}	Write Pulse Width	650			ns	Timing Measurement Reference Level: 1.5 V
t_{CS1}	Chip Enable Setup Time	0		100	ns	Output Load: 1 TTL Gate and $C_L = 100$ pF
t_{CH1}	Chip Enable Hold Time	0			ns	
t_{WR1}	Write Recovery Time	50			ns	
t_{DH1}	Data Hold Time	100			ns	
WRITE CYCLE #2						
t_{WCY2}	Write Cycle	1,050			ns	
t_{AW2}	Address to Write Setup Time	150			ns	Input Pulse Levels: +0.65 to +2.2 V
t_{DW2}	Write Setup Time	650			ns	Input Pulse Rise and Fall Times: 20 ns
t_{WD2}	Write to Output Disable Time	200			ns	Timing Measurement Reference Level: 1.5 V
t_{CS2}	Chip Enable Setup Time	0			ns	Output Load: 1 TTL Gate and $C_L = 100$ pF
t_{CH2}	Chip Enable Hold Time	0			ns	
t_{WR2}	Write Recovery Time	50			ns	
t_{DH2}	Data Hold Time	100			ns	

MM2112-2 (650 ns Access Time)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
READ CYCLE						
t_{RCY}	Read Cycle	650			ns	Input Pulse Levels: +0.65 to +2.2 V
t_A	Access Time			650	ns	Input Pulse Rise and Fall Times: 20 ns
t_{CO}	Chip Enable to Output Time			500	ns	Timing Measurement Reference Level: 1.5 V
t_{CD}	Chip Enable to Output Disable Time	0		150	ns	Output Load: 1 TTL Gate and $C_L = 100$ pF
t_{OH}	Previous Read Data Valid After Change of Address	50			ns	
WRITE CYCLE #1						
t_{WCY1}	Write Cycle	500			ns	
t_{AW1}	Address to Write Setup Time	100			ns	Input Pulse Levels: +0.65 to +2.2 V
t_{DW1}	Write Setup Time	350			ns	Input Pulse Rise and Fall Times: 20 ns
t_{WO1}	Write Pulse Width	350			ns	Timing Measurement Reference Level: 1.5 V
t_{CS1}	Chip Enable Setup Time	0		50	ns	Output Load: 1 TTL Gate and $C_L = 100$ pF
t_{CH1}	Chip Enable Hold Time	0			ns	
t_{WR1}	Write Recovery Time	50			ns	
t_{DH1}	Data Hold Time	50			ns	
WRITE CYCLE #2						
t_{WCY2}	Write Cycle	700			ns	
t_{AW2}	Address to Write Setup Time	100			ns	Input Pulse Levels: +0.65 to +2.2 V
t_{DW2}	Write Setup Time	350			ns	Input Pulse Rise and Fall Times: 20 ns
t_{WD2}	Write to Output Disable Time	200			ns	Timing Measurement Reference Level: 1.5 V
t_{CS2}	Chip Enable Setup Time	0			ns	Output Load: 1 TTL Gate and $C_L = 100$ pF
t_{CH2}	Chip Enable Hold Time	0			ns	
t_{WR2}	Write Recovery Time	50			ns	
t_{DH2}	Data Hold Time	50			ns	

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MM5255, MM5256, MM5257 4k static random access memories

general description

MM5255, MM5256, and MM5257 are 4096-bit random access memories, fabricated with N-channel silicon gate technology. The devices are TTL compatible on all inputs and outputs, including power supplies. All internal timing is generated from the chip enable and read/write control. The memories are designed to retain data in a low power mode of operation selected by a TTL "high" on $\overline{CE}$ pin.

These 4k static RAMs have been designed with minimum production costs as a prime criterion. A unique cell design is used to minimize chip size.

This unique memory cell, along with other design features in the on-chip peripheral circuits, yields a high performance memory device.

features

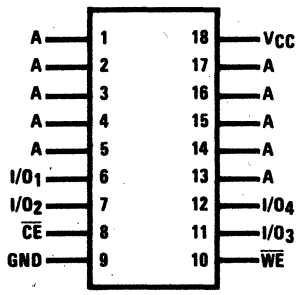
- **Fully TTL Compatible**
- **Single Power Supply, +5V**
- **Fast Access, 250ns**
- **Address and Data Registers On Chip**
- **Common I/O – MM5255 Only**
- **Power with $\overline{CE}$ "High" – < 200mW**
- **Power with $\overline{CE}$ "Low" – 400mW**

organization

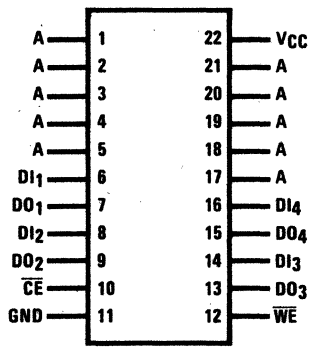
4096 x 1, 18 Pin Package:	MM5257	Separate I/O Pins
1024 x 4, 18 Pin Package:	MM5255	Common I/O Pin
1024 x 4, 22 Pin Package:	MM5256	Separate I/O Pins

connection diagrams

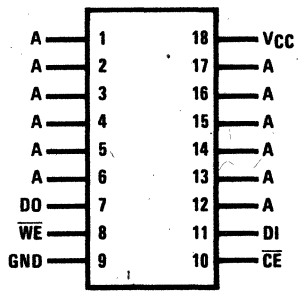
MM5255



MM5256



MM5257



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MM5269 1024-bit (256 × 4) fully decoded static RAM with on chip registers

general description

The National MM5269 is a 256 word x 4 bit Static Random Access Memory device fabricated using N-Channel enhancement mode Silicon Gate technology. Static storage cells eliminate the need for refresh and the additional peripheral circuitry associated with refresh. Data in and data out have the same polarity.

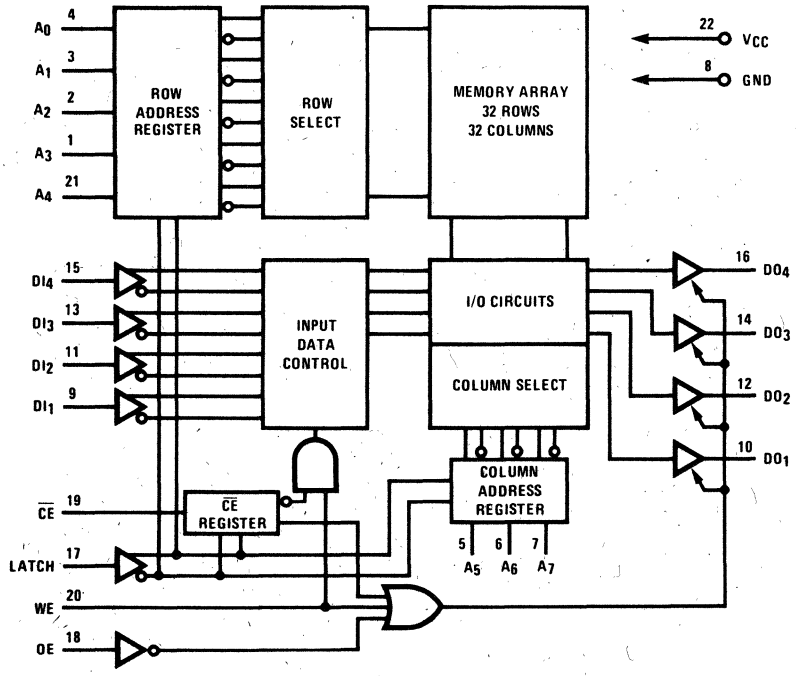
The MM5269 is fully TTL compatible including inputs, outputs and power supply. The chip enable input allows memory expansion and the address latch feature eliminates the need for external address registers. The output enable is provided for systems which use a common input/output data bus. All of the features of this memory device can be combined to make a low cost, high performance and easy to manufacture memory system. System design costs are also minimized because of the ease-of-use of the MM5269.

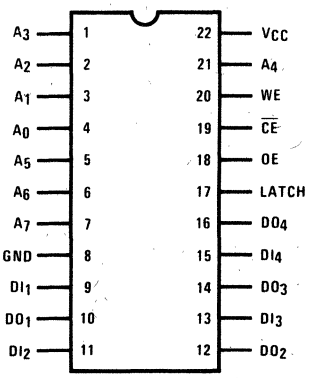
National's Silicon Gate process provides protection against contamination and permits the use of low cost Epoxy B packaging.

features

- Organization 256 Words by 4 Bits
- Access Time – 0.5 to 1.0 μs
- On Chip Address and Chip Enable Registers
- Directly TTL Compatible – All Inputs and Outputs
- Single +5 V Power Supply
- Tri-State ® Output – OR-Tie Capability
- Output Enable for Common Data Bus Systems
- Static Memory – No Refresh Required
- Packaged in a 22 Pin Epoxy B Dual-In-Line

block and connection diagrams





Order Number MM5269D
See Package 5
Order Number MM5269N
See Package 17

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absolute maximum ratings

Voltage at Any Pin	-0.5 V to +7.0 V
Operating Temperature	0°C to +70°C
Storage Temperature	-65°C to +150°C
Power Dissipation	1 Watt
Lead Temperature (10 s)	300°C

dc electrical characteristics (V_{CC} = 5.0 V ± 5%, 0°C ≤ T_A ≤ +70°C)

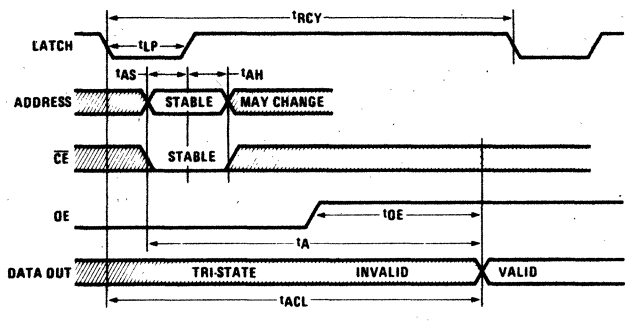
Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
V_{IH}	Logic "1" Input Voltage	2.2		V_{CC}	V	
V_{IL}	Logic "0" Input Voltage	-0.5		0.65	V	
V_{OH}	Logic "1" Output Voltage	2.2			V	I_{OH} = -150 μA
V_{OL}	Logic "0" Output Voltage			0.45	V	I_{OL} = 2.0 mA
I_{LI}	Input Load Current			10	μA	0 V ≤ V_{IN} ≤ 5.0 V
I_{LOH}	Output Leakage Current			15	μA	$\overline{CE}$ = 2.2 V, V_O = 4.0 V
I_{LOL}	Output Leakage Current			-50	μA	$\overline{CE}$ = 2.2 V, V_O = 0.45 V
I_{CC}	Power Supply Current			70	mA	V_{IN} = 5.25 V, I_O = 0 mA, T_A = 0°C

ac electrical characteristics (V_{CC} = 5.0 V ± 5%, 0°C ≤ T_A ≤ +70°C)

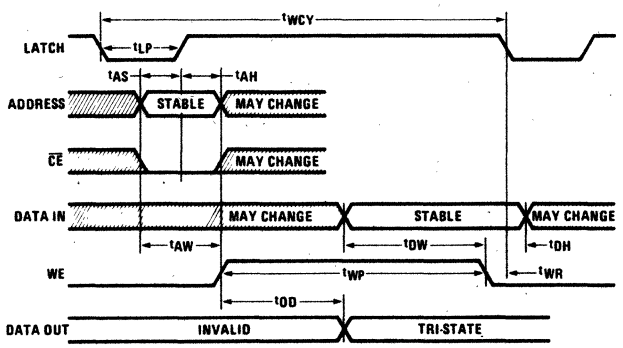
Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
READ CYCLE						
t_{RCY}	Read Cycle	1,000			ns	
t_A or t_{ACL}	Access Time			1,000	ns	Input Pulse Levels: +0.65 to +2.2 V Input Pulse Rise and Fall Times: 20 ns
t_{OE}	Output Enable to Output Time			500	ns	Timing Measurement Reference Level: 1.5 V
t_{LP}	Latch Pulse Width	200			ns	Output Load: 1 TTL Gate and C_L = 100 pF
t_{AS}	ADD & $\overline{CE}$ to Latch Setup Time	100			ns	
t_{AH}	ADD & $\overline{CE}$ to Latch Hold Time	100			ns	
WRITE CYCLE						
t_{WCY}	Write Cycle	1,000			ns	
t_{AW}	Address and CE to Write Setup Time	200			ns	
t_{WP}	Write Pulse Width	650			ns	Input Pulse Levels: +0.65 to +2.2 V
t_{WR}	Write Recovery Time	50			ns	Input Pulse Rise and Fall Times: 20 ns
t_{OD}	Write to Output Disable Time			400	ns	Timing Measurement Reference Level: 1.5 V
t_{DW}	Data Setup Time	350			ns	Output Load: 1 TTL Gate and C_L = 100 pF
t_{DH}	Data Hold Time	100			ns	
t_{CW}	Chip Enable to Write	750			ns	
t_{LP}	Latch Pulse Width	200			ns	
t_{AS}	Add & CE to Latch Setup Time	100			ns	
t_{AH}	Add & CE to Latch Hold Time	100			ns	

switching time waveforms

READ CYCLE (WE = "0")



WRITE CYCLE



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MM4270 TRI-SHARE™ extended temperature range 4096-bit dynamic random access read/write memory

general description

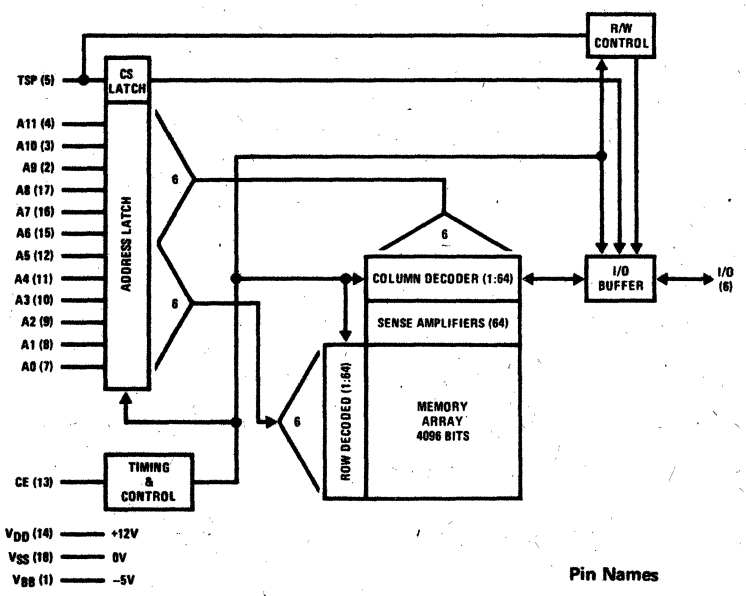
The MM4270 is a 4096-bit dynamic random access memory with TRI-SHARE. Because of this unique design feature, National is able to package a 4k device in an 18-pin dual-in-line package. The device is manufactured using N-channel silicon gate technology with a single transistor cell which provides higher density on a monolithic chip and thus lower cost.

The TRI-SHARE Port (TSP) is a multifunction input that, along with a common input/output, allows National to manufacture an 18-pin version of a 4k RAM. The functions controlled by the TSP are read/write, V_{CC}, and logical chip select. In order to understand how the TSP works, consider the timing diagrams. The state of the TSP at the leading edge of the chip enable clock determines whether the device is selected. If it is at a TTL high level, the chip is selected and the device goes into a read mode after chip enable goes high. This high level also performs a V_{CC} function in that it enables a reference voltage for a TTL high output. The supply for the output buffer is V_{DD}, not the TRI-SHARE Port; thus, no special driver is required. In order to perform a write, the TSP must be pulsed low after the minimum hold time and the appropriate data placed on the I/O. When the MM4270 goes into write, the output circuit is disabled. If the TSP is low at the start of the cycle, the memory is not selected but it will be refreshed if the chip enable clock is pulsed.

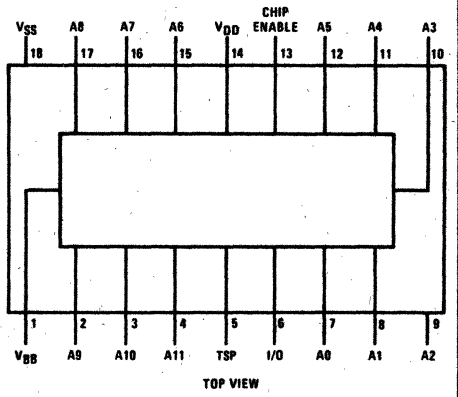
features

- 4096 x 1 bit organization
- Access time 270 ns maximum
- Cycle time 470 ns minimum
- TRI-SHARE port
- High memory density—18-pin package
- TTL compatible inputs (except chip enable)
- TRI-STATE® common input/output
- Registers on chip for addresses and chip select
- Two power supplies, +12V, −5V
- Simple read-modify-write operation

block and connection diagrams



Dual-In-Line Package



Pin Names

A0–A11	Address Inputs*	V_{BB}	Power (−5V)
CE	Chip Enable	V_{DD}	Power (+12V)
TSP	TRI-SHARE Port	V_{SS}	Ground
I/O	$D_{IN}/\overline{D_{OUT}}$		

*Refresh Addess A0–A5

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absolute maximum ratings

Operating Temperature Range	−55°C to +85°C
Storage Temperature	−65°C to +150°C
All Input or Output Voltages with Respect to the Most Negative Supply Voltage, V_{BB}	−0.3V to +25V
Supply Voltages V_{DD} and V_{SS} with Respect to V_{BB}	−0.3V to +20V
Power Dissipation	1.0W

ac electrical characteristics

T_A = −55°C to +85°C, V_{DD} = 12V ±5%, V_{BB} (Note 2) = −5V ±10%, V_{SS} = 0V, unless otherwise noted

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP(3)	MAX	UNITS
I_{LI}	Input Load Current	V_{IN} = 0V to V_{IH} max, (All Inputs Except CE)		0.01	10	μA
I_{LC}	Input Load Current	V_{IN} = 0V to V_{IHC} max		0.01	10	μA
$\|I_{LO}\|$	Output Leakage Current Up For High Impedance State	CE = V_{ILC}, V_O = 0V to 5.25V		0.01	10	μA
I_{DD1}	V_{DD} Supply Current During CE "OFF"	CE = −1V to +0.6V, (Note 4)		110	200	μA
I_{DD2}	V_{DD} Supply Current During CE "ON"	CE = V_{IHC}, T_A = 25°C		20	50	mA
$I_{DD\,AV1}$	Average V_{DD} Current	T_A = 25°C, Cycle Time = 470 ns, t_{CE} = 300 ns		35	70	mA
I_{BB}	V_{BB} Supply Current Average			5	100	μA
V_{IL}	Input Low Voltage	t_T = 20 ns, *(Figure 4)*	−1.0		0.6	V
V_{IH}	Input High Voltage		2.2		V_{CC}+1	V
V_{ILC}	CE Input Low Voltage		−1.0		1.0	V
V_{IHC}	CE Input High Voltage		V_{DD}−1		V_{DD}+1	V
V_{OL}	Output Low Voltage	I_{OL} = 2.0 mA	0.0		0.45	V
V_{OH}	Output High Voltage	I_{OH} = −2.0 mA	2.4			V

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: The only requirement for the sequence of applying voltage to the device is that V_{DD} or V_{SS} should never be 0.3V more negative than V_{BB}.

Note 3: Typical values are for T_A = 25°C and nominal power supply voltages.

Note 4: The I_{DD} current is to V_{SS}. The I_{BB} current is the sum of all leakage currents.

ac electrical characteristics T_A = −55°C to +85°C, V_{DD} = 12V ±5%, V_{BB} = −5V ±10%

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ, WRITE, READ/MODIFY/WRITE, AND REFRESH CYCLE						
t_{REF}	Time Between Refresh				1	ms
t_{AC}	Address to CE Set-Up Time	t_{AC} is Measured From End of Address Transition	0			ns
t_{AH}	Address Hold Time		100			ns
t_{CC}	CE "OFF" Time		130			ns
t_T	CE Transition Time		10		40	ns
t_{CF}	CE "OFF" to Output High Impedance State		0			ns
t_{TC}	TRI-SHARE Port to CE Set-Up Time		0			ns
t_{TH}	TRI-SHARE Port Hold Time		50			ns
READ CYCLE						
t_{CY}	Cycle Time		470			ns
t_{CE}	CE "ON" Time	t_T = 20 ns	300		3000	ns
t_{CO}	CE Output Delay	C_{LOAD} = 50 pF, Load = One TTL Gate			250	ns
t_{ACC}	Address to Output Access	Ref 1 = 2.0V, Ref 0 = 0.8V			270	ns
t_{TL}	CE to TSP	$t_{ACC} = t_{AC} + t_{CO} + t_T$	0			ns

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ac electrical characteristics (Continued) $T_A = -55°C$ to $+85°C$, $V_{DD} = 12V \pm 5\%$, $V_{BB} = -5V \pm 10\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
WRITE CYCLE						
t_{CY}	Cycle Time		470			ns
t_{CE}	CE "ON" Time		300		3000	ns
t_{WI}	TSP to CE "OFF"		150			ns
t_{CW}	CE to TSP	$t_T = 20$ ns			85	ns
t_D	D_{IN} to CE "OFF"		150			ns
t_{DH}	D_{IN} Hold Time		0			ns
t_{WP}	TSP Pulse Width		50			ns

ac electrical characteristics (Continued) $T_A = -55°C$ to $+85°C$, $V_{DD} = 12V \pm 5\%$, $V_{BB} = -5V \pm 10\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ/MODIFY/WRITE CYCLE						
t_{RWC}	Read Modify Write (RMW) Cycle Time		650			ns
t_{CRW}	CE Width During RMW		480		3000	ns
t_{WC}	TSP to CE "ON"	$t_T = 20$ ns	0			ns
t_{W2}	TSP to CE "OFF"	$C_{LOAD} = 50$ pF, Load = One TTL Gate	200			ns
t_{WP}	TSP Pulse Width	Ref 1 = 2.0V, Ref 0 = 0.8V	50			ns
t_D	D_{IN} to CE "OFF"	$t_{ACC} = t_{AC} + t_{CO} + t_T$	150			ns
t_{DH}	D_{IN} Hold Time		0			ns
t_{CO}	CE to Output Delay				250	ns
t_{ACC}	Access Time				270	ns
t_{WD}	TSP to Output High Impedance				50	ns
t_M	Modify Time		0			ns
CAPACITANCE (Note 1)						
C_{AD}	Address Capacitance, $\overline{CS}$	$V_{IN} = V_{SS}$		2	6	pF
C_{CE}	CE Capacitance	$V_{IN} = V_{SS}$		15	25	pF
$C_{I/O}$	Data I/O Capacitance	$V_{OUT} = 0V$		8	10	pF
C_{IN}	TSP Capacitance	$V_{IN} = V_{SS}$		5	6	pF

Note 1: Capacitance measured with Boonton Meter or effective capacitance calculated from the equation $C = I\Delta t/\Delta V$ with the current equal to a constant 20 mA.

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MM4280 4096-bit dynamic random access read/write memory with extended temperature range

general description

National's MM4280 is a 4096 word by 1 bit dynamic RAM. It incorporates the latest memory design features and can be used in a wide variety of applications, from those which require very high speed to ones where low cost and large bit capacity are the prime criteria.

The MM4280 must be refreshed every 1 ms. This can be accomplished by performing a read cycle at each of the 64 row addresses (A0–A5). The chip select input can be either high or low for refresh. Addresses (A6–A11) must have a stable address during the refresh cycle. Any address is satisfactory as long as the address set-up and hold times are met. The chip select input can be either high or low for refresh.

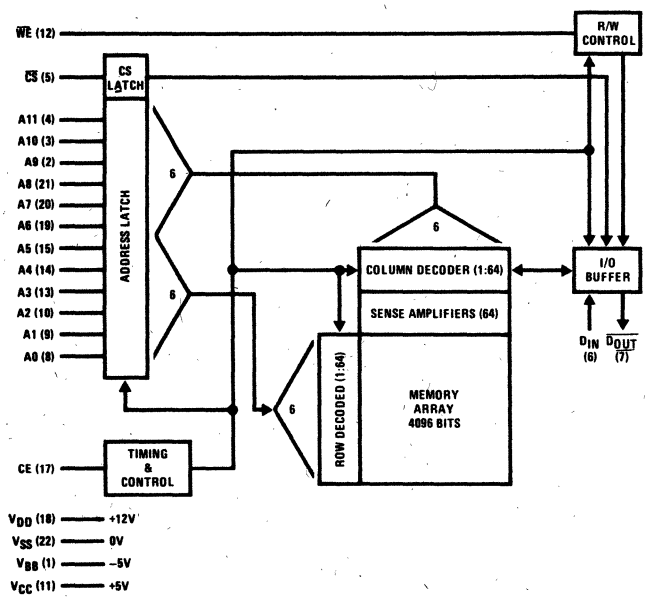
The MM4280 has been designed with minimum production costs as a prime criterion. It is fabricated using N-channel silicon gate MOS technology, which is an ideal choice for high density integrated circuits. The MM4280 uses a single transistor cell to minimize the device area.

The single device cell, along with unique design features in the on-chip peripheral circuits, yields a high performance memory device.

features

- Extended temperature range: −55°C to +85°C
- Organization: 4096 x 1
- Access time 270 ns maximum
- Cycle time 470 ns minimum
- Easy system interface
  - One high voltage input—chip enable
  - TTL compatible—all other inputs and outputs
- Address registers on-chip
- TRI-STATE® output
- Simple read-modify-write operation
- Industry standard pin configuration

block diagram



Memory Inverts From Data In to Data Out

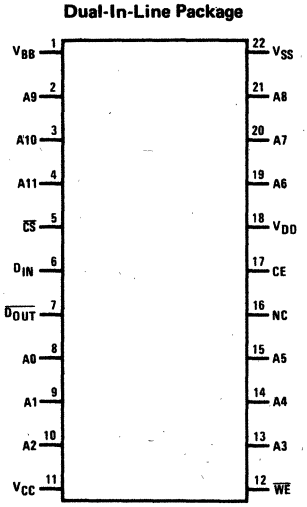
Pin Numbers

A0–A11	Address Inputs *	V_{BB}	Power (−5V)
CE	Chip Enable	V_{CC}	Power (+5V)
$\overline{CS}$	Chip Select	V_{DD}	Power (+12V)
D_{IN}	Data Input	V_{SS}	Ground
$\overline{D_{OUT}}$	Data Output	$\overline{WE}$	Write Enable
NC	Not Connected		

* Refresh Address A0–A5

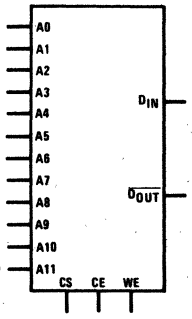
connection diagram

Dual-In-Line Package



TOP VIEW

logic symbol



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absolute maximum ratings (Note 1)

Operating Temperature Range	−55°C to +85°C
Storage Temperature	−65°C to +150°C
Voltage on any Pin Relative to V_{BB} ($V_{SS} - V_{BB} \geq 4.5V$)	−0.3V to +20V
Power Dissipation	1.25W

dc electrical characteristics

T_A = −55°C to +85°C, V_{DD} = 12V ±5%, V_{CC} = 5V ±5%, V_{BB} (Note 2) = −5V ±10%, V_{SS} = 0V, unless otherwise noted.

	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
I_{LI}	Input Load Current	V_{IN} = 0V to V_{IH} max, (All Inputs Except CE)		0.01	10	μA
I_{LC}	Input Load Current	V_{IN} = 0V to V_{IHC} max		0.01	10	μA
$\|I_{LO}\|$	Output Leakage Current Up For High Impedance State	CE = V_{ILC} or $\overline{CS}$ = V_{IH}, V_O = 0V to 5.25V		0.01	10	μA
I_{DD1}	V_{DD} Supply Current During CE "OFF"	CE = −1V to 0.6V, (Note 4)		110	200	μA
I_{DD2}	V_{DD} Supply Current During CE "ON"	CE = V_{IHC}, T_A = 25°C		20	50	mA
I_{DDAV1}	Average V_{DD} Current	Cycle Time = 470 ns, t_{CE} = 300 ns		35	70	mA
I_{CC1}	V_{CC} Supply Current During CE "OFF"	CE = V_{ILC} or $\overline{CS}$ = V_{IH} (Note 5)		0.01	10	μA
I_{BB}	V_{BB} Supply Current Average			5	100	μA
V_{IL}	Input Low Voltage	t_T = 20 ns	−1.0		0.6	V
V_{IH}	Input High Voltage		2.2		V_{CC}+1	V
V_{ILC}	CE Input Low Voltage		−1.0		1.0	V
V_{IHC}	CE Input High Voltage		V_{DD}−1		V_{DD}+1	V
V_{OL}	Output Low Voltage	I_{OL} = 2 mA	0		0.45	V
V_{OH}	Output High Voltage	I_{OH} = −2 mA	2.4		V_{CC}	V

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: All voltages referenced to V_{SS} and V_{BB} must be applied before and removed after other supply voltages.

Note 3: Typical values are for T_A = 25°C and nominal power supply voltages.

Note 4: The I_{DD} and I_{CC} currents flow to V_{SS}. The I_{BB} current is the sum of all leakage currents.

Note 5: During CE "ON" V_{CC} supply current is dependent on output loading, V_{CC} is connected to output buffer only.

ac electrical characteristics T_A = −55°C to +85°C, V_{DD} = 12V ±5%, V_{CC} = 5V ±5%, V_{BB} = −5V ±10%

	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ, WRITE, READ/MODIFY/WRITE, AND REFRESH CYCLE						
t_{REF}	Time Between Refresh				1	ms
t_{AC}	Address to CE Set-Up Time	t_{AC} is Measured From End of Address Transition	0			ns
t_{AH}	Address Hold Time		100			ns
t_{CC}	CE "OFF" Time		130			ns
t_T	CE Transition Time		10		40	ns
t_{CF}	CE "OFF" to Output High Impedance State		0			ns
READ CYCLE						
t_{CY}	Cycle Time		470			ns
t_{CE}	CE "ON" Time	C_{LOAD} = 50 pF, Load = 1 TTL Gate, Ref = 2V, $t_{ACC} = t_{AC} + t_{CO} + 1\ t_T$	300		3000	ns
t_{CO}	CE Output Delay				250	ns
t_{ACC}	Address to Output Access				270	ns
t_{WL}	CE to $\overline{WE}$		0			ns
t_{WC}	$\overline{WE}$ to CE "ON"		0			ns

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ac electrical characteristics (Continued)

PARAMETER		CONDITIONS	MIN	TYP	MAX	UNITS
WRITE CYCLE						
t_{CY}	Cycle Time		470			ns
t_{CE}	CE "ON" Time		300		3000	ns
t_W	$\overline{WE}$ to CE "OFF"		150			ns
t_{CW}	CE to $\overline{WE}$	t_T = 20 ns	130			ns
t_D	D_{IN} to CE Set-Up		150			ns
t_{DH}	D_{IN} Hold Time		0			ns
t_{WP}	$\overline{WE}$ Pulse Width		50			ns

ac electrical characteristics (Continued) $T_A = -55°C$ to $+85°C$, $V_{DD} = 12V \pm 5V \pm 5\%$, $V_{BB} = -5V \pm 10\%$

PARAMETER		CONDITIONS	MIN	TYP	MAX	UNITS
READ/MODIFY/WRITE CYCLE						
t_{RWC}	Read/Modify/Write (RMW) Cycle Time	t_T = 20 ns, C_{LOAD} = 50 pF, Load = 1 TTL Gate, Ref = 2V, $t_{ACC} = t_{AC} + t_{CO} + 1\ t_T$	590			ns
t_{CRW}	CE Width During RMW		420		3000	ns
t_{WC}	$\overline{WE}$ to CE "ON"		0			ns
t_W	$\overline{WE}$ to CE "OFF"		150			ns
t_{WP}	$\overline{WE}$ Pulse Width		50			ns
t_D	D_{IN} to CE Set-Up		150			ns
t_{DH}	D_{IN} Hold Time		0			ns
t_{CO}	CE to Output Delay				250	ns
t_{WO}	$\overline{WE}$ to $\overline{D_{OUT}}$ Invalid		0			ns
t_{ACC}	Access Time				270	ns
CAPACITANCE (Note 1) $T_A = 25°C$						
C_{AD}	Address Capacitance, CS	$V_{IN} = V_{SS}$		2	6	pF
C_{CE}	CE Capacitance	$V_{IN} = V_{SS}$		15	25	pF
C_{OUT}	Data Output Capacitance	$V_{OUT} = 0V$		5	10	pF
C_{IN}	D_{IN} and $\overline{WE}$ Capacitance	$V_{IN} = V_{SS}$		4	6	pF

Note 1: Capacitance measured with Boonton Meter or effective capacitance calculated from the equation $C = I\Delta t/\Delta V$ with the current equal to a constant 20 mA.

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MM5270 TRI-SHARE™ 4096-bit fully decoded dynamic random access read/write memory

general description

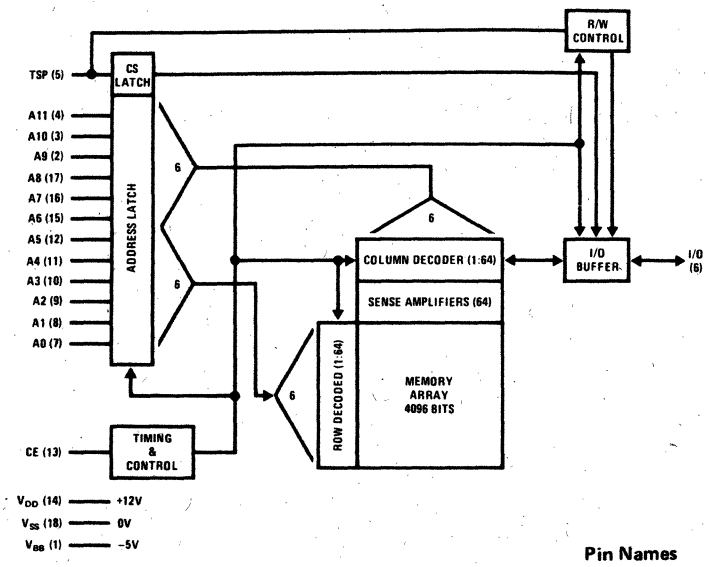
The MM5270 is a 4096-bit dynamic random access memory with TRI-SHARE. Because of this unique design feature, National is able to package a 4k device in an 18-pin dual-in-line package. The device is manufactured using N-channel silicon gate technology with a single transistor cell which provides higher density on a monolithic chip and thus lower cost.

The TRI-SHARE Port (TSP) is a multifunction input that, along with a common input/output, allows National to manufacture an 18-pin version of a 4k RAM. The functions controlled by the TSP are read/write, V_{CC}, and logical chip select. In order to understand how the TSP works, consider the timing diagrams. The state of the TSP at the leading edge of the chip enable clock determines whether the device is selected. If it is at a TTL high level, the chip is selected and the device goes into a read mode after chip enable goes high. This high level also performs a V_{CC} function in that it enables a reference voltage for a TTL high output. The supply for the output buffer is V_{DD}, not the TRI-SHARE Port; thus, no special driver is required. In order to perform a write, the TSP must be pulsed low after the minimum hold time and the appropriate data placed on the I/O. When the MM5270 goes into write, the output circuit is disabled. If the TSP is low at the start of the cycle, the memory is not selected but it will be refreshed if the chip enable clock is pulsed.

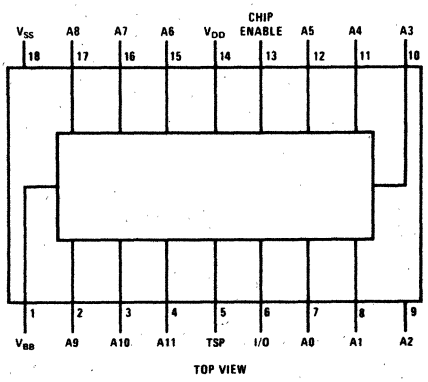
features

- 4096 x 1 bit organization
- Access time 200 ns maximum
- Cycle time 400 ns minimum
- TRI-SHARE port
- High memory density—18-pin package
- TTL compatible inputs (except chip enable)
- TRI-STATE® common input/output
- Registers on chip for addresses and chip select
- Two power supplies, +12V, −5V
- Simple read-modify-write operation

block and connection diagrams



Dual-In-Line Package



Order Number MM5270D
See Package 4

Pin Names

A0–A11	Address Inputs*	V_{BB}	Power (−5V)
CE	Chip Enable	V_{DD}	Power (+12V)
TSP	TRI-SHARE Port	V_{SS}	Ground
I/O	D_{IN}/D_{OUT}		

*Refresh Addess A0–A5

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absolute maximum ratings (Note 1)

Operating Temperature Range	0°C to +70°C
Storage Temperature	−65°C to +150°C
All Input or Output Voltages with Respect to the Most Negative Supply Voltage, V_{BB}	−0.3V to +25V
Supply Voltages V_{DD} and V_{SS} with Respect to V_{BB}	−0.3V to +20V
Power Dissipation	1.0W

dc electrical characteristics

T_A = 0°C to +70°C, V_{DD} = +12V ±5%, V_{BB} (Note 2) = −5V ±5%, V_{SS} = 0V, unless otherwise noted

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP (3)	MAX	UNITS
I_{LI}	Input Load Current	V_{IN} = 0V to V_{IH} max, (All Inputs Except CE)		0.01	10	μA
I_{LC}	Input Load Current	V_{IN} = 0V to V_{IHC} max		0.01	10	μA
I_{LO}	Output Leakage Current Up For High Impedance State	CE = V_{ILC}, V_O = 0V to 5.25V		0.01	10	μA
I_{DD1}	V_{DD} Supply Current During CE "OFF"	CE = −1V to +0.6V, (Note 4)		110		μA
I_{DD2}	V_{DD} Supply Current During CE "ON"	CE = V_{IHC}, T_A = 25°C		20		mA
$I_{DD\ AV1}$	Average V_{DD} Current	T_A = 25°C, Cycle Time = 400 ns, t_{CE} = 230 ns		35		mA
$I_{DD\ AV2}$	Average V_{DD} Current	T_A = 25°C, Cycle Time = 1000 ns, t_{CE} = 230 ns		15		mA
I_{BB}	V_{BB} Supply Current Average			5	100	μA
V_{IL}	Input Low Voltage	t_T = 20 ns, (*Figure 4*)	−1.0		0.6	V
V_{IH}	Input High Voltage		2.4		V_{CC}+1	V
V_{ILC}	CE Input Low Voltage		−1.0		1.0	V
V_{IHC}	CE Input High Voltage		V_{DD}−1		V_{DD}+1	V
V_{OL}	Output Low Voltage	I_{OL} = 2.0 mA	0.0		0.45	V
V_{OH}	Output High Voltage	I_{OH} = −2.0 mA	2.4			V

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: The only requirement for the sequence of applying voltage to the device is that V_{DD} or V_{SS} should never be 0.3V more negative than V_{BB}.

Note 3: Typical values are for T_A = 25°C and nominal power supply voltages.

Note 4: The I_{DD} current is to V_{SS}. The I_{BB} current is the sum of all leakage currents.

ac electrical characteristics T_A = 0°C to +70°C, V_{DD} = 12V ±5%, V_{BB} = −5V ±5%

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ, WRITE, READ/MODIFY/WRITE, AND REFRESH CYCLE						
t_{REF}	Time Between Refresh				2	ms
t_{AC}	Address to CE Set-Up Time	t_{AC} is Measured From End of Address Transition	0			ns
t_{AH}	Address Hold Time		50			ns
t_{CC}	CE "OFF" Time		130			ns
t_T	CE Transition Time		10		40	ns
t_{CF}	CE "OFF" to Output High Impedance State		0			ns
t_{TC}	TRI-SHARE Port to CE Set-Up Time		0			ns
t_{TH}	TRI-SHARE Port Hold Time		50			ns
READ CYCLE						
t_{CY}	Cycle Time	t_T = 20 ns C_{LOAD} = 50 pF, Load = One TTL Gate Ref 1 = 2.0V, Ref 0 = 0.8V $t_{ACC} = t_{AC} + t_{CO} + t_T$	400			ns
t_{CE}	CE "ON" Time		230		3000	ns
t_{CO}	CE Output Delay				180	ns
t_{ACC}	Address to Output Access				200	ns
t_{TL}	CE to TSP		0			ns

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ac electrical characteristics (con't) $T_A = 0°C$ to $+70°C$, $V_{DD} = 12V \pm 5\%$, $V_{BB} = -5V \pm 5\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
WRITE CYCLE						
t_{CY}	Cycle Time		400			ns
t_{CE}	CE "ON" Time		230		3000	ns
t_{WI}	TSP to CE "OFF"		150			ns
t_{CW}	CE to TSP	$t_T = 20$ ns			85	ns
t_D	D_{IN} to CE "OFF"		150			ns
t_{DH}	D_{IN} Hold Time		0			ns
t_{WP}	TSP Pulse Width		50			ns

ac electrical characteristics (con't) $T_A = 0°C$ to $+70°C$, $V_{DD} = 12V \pm 5\%$, $V_{BB} = -5V \pm 5\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ/MODIFY/WRITE CYCLE						
t_{RWC}	Read Modify Write (RMW) Cycle Time		580			ns
t_{CRW}	CE Width During RMW		410		3000	ns
t_{WC}	TSP to CE "ON"	$t_T = 20$ ns	0			ns
t_{W2}	TSP to CE "OFF"	$C_{LOAD} = 50$ pF, Load = One TTL Gate	200			ns
t_{WP}	TSP Pulse Width	Ref 1 - 2.0V, Ref 0 = 0.8V	50			ns
t_D	D_{IN} to CE "OFF"	$t_{ACC} = t_{AC} + t_{CO} + t_T$	150			ns
t_{DH}	D_{IN} Hold Time		0			ns
t_{CO}	CE to Output Delay				180	ns
t_{ACC}	Access Time				200	ns
t_{WD}	TSP to Output High Impedance				50	ns
t_M	Modify Time		0			ns
CAPACITANCE (Note 1)						
C_{AD}	Address Capacitance, $\overline{CS}$	$V_{IN} = V_{SS}$		2		pF
C_{CE}	CE Capacitance	$V_{IN} = V_{SS}$		15		pF
$C_{I/O}$	Data I/O Capacitance	$V_{OUT} = 0V$		8		pF
C_{IN}	TSP Capacitance	$V_{IN} = V_{SS}$		5		pF

Note 1: Capacitance measured with Boonton Meter or effective capacitance calculated from the equation $C = I\Delta t/\Delta V$ with the current equal to a constant 20 mA.

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MM5270A TRI-SHARE™ 4096-bit fully decoded dynamic random access read/write memory

general description

The MM5270A is a 4096-bit dynamic random access memory with TRI-SHARE. Because of this unique design feature, National is able to package a 4k device in an 18-pin dual-in-line package. The device is manufactured using N-channel silicon gate technology with a single transistor cell which provides higher density on a monolithic chip and thus lower cost.

The TRI-SHARE Port (TSP) is a multifunction input that, along with a common input/output, allows National to manufacture an 18-pin version of a 4k RAM. The functions controlled by the TSP are read/write, V_{CC}, and logical chip select. In order to understand how the TSP works, consider the timing diagrams. The state of the TSP at the leading edge of the chip enable clock determines whether the device is selected. If it is at a TTL high level, the chip is selected and the device goes into a read mode after chip enable goes high. This high level also enables a reference voltage for a TTL high output. The supply for the output buffer is V_{DD}, not the TRI-SHARE Port; thus, no special driver is required. In order to perform a write, the TSP must be pulsed low after the minimum hold time and the appropriate data placed on the I/$\overline{O}$. When the MM5270A goes into write, the output circuit is disabled. If the TSP is low at the start of the cycle, the memory is not selected, but it will be refreshed if the chip enable clock is pulsed.

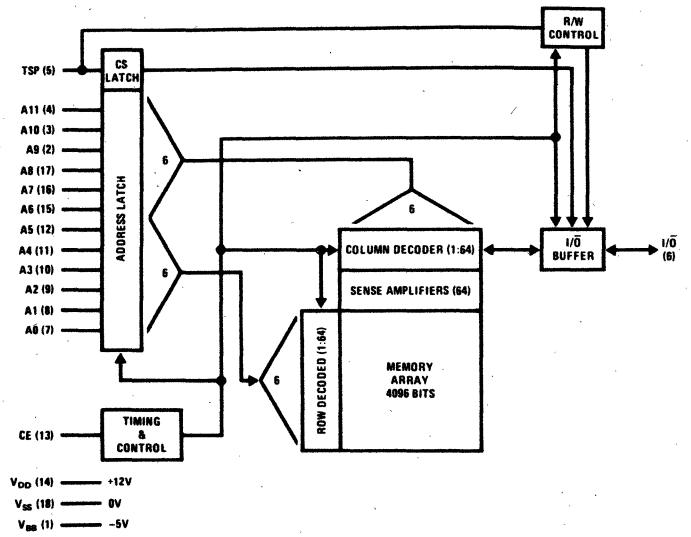
The RAM must be refreshed every 2 ms. This can be accomplished by performing a cycle at each of the 64 row addresses (A0–A5).

Addresses (A6–A11) must have a stable address during the refresh cycle. Any address is satisfactory as long as the address set-up and hold times are met. The chip select input can be either high or low for refresh.

features

- 4096 x 1 bit organization
- Access time—150 ns max
- Cycle time—300 ns min
- TRI-SHARE port
- High memory density—18-pin package
- TTL compatible inputs (except chip enable)
- TRI-STATE® common input/output
- Registers on chip for addresses and chip select
- Two power supplies, +12V, −5V
- Simple read-modify-write operation

block diagram



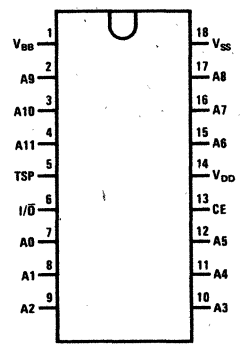
Pin Names

*A0–A11	Address Inputs	V_{BB}	Power (−5V)
CE	Chip Enable	V_{DD}	Power (+12V)
TSP	TRI-SHARE Port	V_{SS}	Ground
I/$\overline{O}$	$D_{IN}/\overline{D_{OUT}}$		

*Row address A0–A5

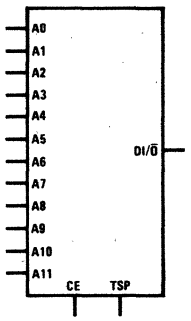
connection diagram

Dual-In-Line Package



TOP VIEW

logic symbol



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absolute maximum ratings

Operating Temperature Range	0°C to +70°C
Storage Temperature	−65°C to +150°C
Voltage on Any Pin Relative to V_{BB}	−0.3V to +20V
($V_{SS} = V_{BB} \geq 4.5V$)	
Power Dissipation	1.0W
Lead Temperature (Soldering, 10 seconds)	300°C

dc electrical characteristics

T_A = 0°C to +70°C, V_{DD} = +12V ±5%, V_{BB} (Note 2) = −5V ±5%, V_{SS} = 0V, unless otherwise noted

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP (3)	MAX	UNITS
I_{LI}	Input Load Current	V_{IN} = 0V to V_{IH} max, (All Inputs Except CE)		0.01	10	μA
I_{LC}	Input Load Current	V_{IN} = 0V to V_{IHC} max		0.01	10	μA
$\|I_{LO}\|$	Output Leakage Current Up For High Impedance State	CE = V_{ILC}, V_O = 0V to 5.25V		0.01	10	μA
I_{DD1}	V_{DD} Supply Current During CE "OFF"	CE = −1V to +0.6V, (Note 4)		110		μA
I_{DD2}	V_{DD} Supply Current During CE "ON"	CE = V_{IHC}, T_A = 25°C		20		mA
$I_{DD\ AV1}$	Average V_{DD} Current	T_A = 25°C, Cycle Time = 400 ns, t_{CE} = 160 ns		45		mA
$I_{DD\ AV2}$	Average V_{DD} Current	T_A = 25°C, Cycle Time = 1000 ns, t_{CE} = 160 ns		15		mA
I_{BB}	V_{BB} Supply Current Average			5	100	μA
V_{IL}	Input Low Voltage	t_T = 20 ns, (*Figure 4*)	−1.0		0.6	V
V_{IH}	Input High Voltage		2.4		V_{CC}+1	V
V_{ILC}	CE Input Low Voltage		−1.0		1.0	V
V_{IHC}	CE Input High Voltage		V_{DD}−1		V_{DD}+1	V
V_{OL}	Output Low Voltage	I_{OL} = 2.0 mA	0.0		0.45	V
V_{OH}	Output High Voltage	I_{OH} = −2.0 mA	2.4			V

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: All voltages referenced to V_{SS}. V_{BB} must be applied before and removed after other supply voltages.

Note 3: Typical values are for T_A = 25°C and nominal power supply voltages.

Note 4: The I_{DD} current is to V_{SS}. The I_{BB} current is the sum of all leakage currents.

ac electrical characteristics T_A = 0°C to +70°C, V_{DD} = 12V ±5%, V_{BB} = −5V ±5%

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ, WRITE, READ/MODIFY/WRITE, AND REFRESH CYCLE						
t_{REF}	Time Between Refresh				2	ms
t_{AC}	Address to CE Set-Up Time	t_{AC} is Measured From End of Address Transition	0			ns
t_{AH}	Address Hold Time		40			ns
t_{CC}	CE "OFF" Time		100			ns
t_T	CE Transition Time		10		40	ns
t_{CF}	CE "OFF" to Output High Impedance State		0			ns
t_{TC}	TRI-SHARE Port to CE Set-Up Time		0			ns
t_{TH}	TRI-SHARE Port Hold Time		40			ns
READ CYCLE						
t_{CY}	Cycle Time	t_T = 20 ns C_{LOAD} = 50 pF, Load = One TTL Gate Ref 1 = 2.0V, Ref 0 = 0.8V $t_{ACC} = t_{AC} + t_{CO} + t_T$	300			ns
t_{CE}	CE "ON" Time		160		3000	ns
t_{CO}	CE Output Delay				130	ns
t_{ACC}	Address to Output Access				150	ns
t_{TL}	CE to TSP		0			ns

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ac electrical characteristics (con't) $T_A = 0°C$ to $+70°C$, $V_{DD} = 12V \pm 5\%$, $V_{BB} = -5V \pm 5\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
WRITE CYCLE						
t_{CY}	Cycle Time		300			ns
t_{CE}	CE "ON" Time		160		3000	ns
t_{WI}	TSP to CE "OFF"		80			ns
t_{CW}	CE to TSP	$t_T = 20$ ns			75	ns
t_D	D_{IN} to CE "OFF"		80			ns
t_{DH}	D_{IN} Hold Time		0			ns
t_{WP}	TSP Pulse Width		50			ns

ac electrical characteristics (con't) $T_A = 0°C$ to $+70°C$, $V_{DD} = 12V \pm 5\%$, $V_{BB} = -5V \pm 5\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ/MODIFY/WRITE CYCLE						
t_{RWC}	Read Modify Write (RMW) Cycle Time		400			ns
t_{CRW}	CE Width During RMW		260		3000	ns
t_{WC}	TSP to CE "ON"	$t_T = 20$ ns	0			ns
t_{W2}	TSP to CE "OFF"	$C_{LOAD} = 50$ pF, Load = One TTL Gate	120			ns
t_{WP}	TSP Pulse Width	Ref 1 - 2.0V, Ref 0 = 0.8V	50			ns
t_D	D_{IN} to CE "OFF"	$t_{ACC} = t_{AC} + t_{CO} + t_T$	80			ns
t_{DH}	D_{IN} Hold Time		0			ns
t_{CO}	CE to Output Delay				130	ns
t_{ACC}	Access Time				150	ns
t_{WD}	TSP to Output High Impedance				40	ns
t_M	Modify Time		0			ns
CAPACITANCE (Note 1)						
C_{AD}	Address Capacitance, $\overline{CS}$	$V_{IN} = V_{SS}$		2		pF
C_{CE}	CE Capacitance	$V_{IN} = V_{SS}$		15		pF
$C_{I/\overline{O}}$	Data I/$\overline{O}$ Capacitance	$V_{OUT} = 0V$		8		pF
C_{IN}	TSP Capacitance	$V_{IN} = V_{SS}$		5		pF

Note 1: Capacitance measured with Boonton Meter or effective capacitance calculated from the equation $C = I\Delta t/\Delta V$ with the current equal to a constant 20 mA.

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MOS RAMs

MM5270-5 TRI-SHARE™ 4096-bit random access read/write memory

general description

The MM5270-5 is a slower speed version of National's MM5270 dynamic RAM. Please refer to the MM5270 specification for pin configuration, block diagram and switching time waveforms.

features

- Access time—270 ns
- Cycle time—470 ns

absolute maximum ratings (Note 1)

Operating Temperature Range	0°C to +70°C
Storage Temperature	−65°C to +150°C
All Input or Output Voltages with Respect to the Most Negative Supply Voltage, V_{BB}	−0.3V to +25V
Supply Voltages V_{DD} and V_{SS} with Respect to V_{BB}	−0.3V to +20V
Power Dissipation	1.0W

Order Number MM5270D-5
See Package 4

dc electrical characteristics

T_A = 0°C to +70°C, V_{DD} = +12V ±5%, V_{BB} (Note 2) = −5V ±5%, V_{SS} = 0V, unless otherwise noted

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP (3)	MAX	UNITS
I_{LI}	Input Load Current	V_{IN} = 0V to V_{IH} max, (All Inputs Except CE)		0.01	10	μA
I_{LC}	Input Load Current	V_{IN} = 0V to V_{IHC} max		0.01	10	μA
$\|I_{LO}\|$	Output Leakage Current Up For High Impedance State	CE = V_{ILC}, V_O = 0V to 5.25V		0.01	10	μA
I_{DD1}	V_{DD} Supply Current During CE "OFF"	CE = −1V to +0.6V, (Note 4)		110		μA
I_{DD2}	V_{DD} Supply Current During CE "ON"	CE = V_{IHC}, T_A = 25°C		20		mA
$I_{DD\ AV1}$	Average V_{DD} Current	T_A = 25°C, Cycle Time = 470 ns, t_{CE} = 300 ns		35		mA
$I_{DD\ AV2}$	Average V_{DD} Current	T_A = 25°C, Cycle Time = 1000 ns, t_{CE} = 300 ns		15		mA
I_{BB}	V_{BB} Supply Current Average			5	100	μA
V_{IL}	Input Low Voltage	t_T = 20 ns	−1.0		0.6	V
V_{IH}	Input High Voltage		2.4		V_{CC}+1	V
V_{ILC}	CE Input Low Voltage		−1.0		1.0	V
V_{IHC}	CE Input High Voltage		V_{DD}−1		V_{DD}+1	V
V_{OL}	Output Low Voltage	I_{OL} = 2.0 mA	0.0		0.45	V
V_{OH}	Output High Voltage	I_{OH} = −2.0 mA	2.4			V

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: The only requirement for the sequence of applying voltage to the device is that V_{DD} or V_{SS} should never be 0.3V more negative than V_{BB}.

Note 3: Typical values are for T_A = 25°C and nominal power supply voltages.

Note 4: The I_{DD} current is to V_{SS}. The I_{BB} current is the sum of all leakage currents.

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ac electrical characteristics

$T_A = 0°C$ to $+70°C$, $V_{DD} = 12V \pm 5\%$, $V_{BB} = -5V \pm 5\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ, WRITE, READ/MODIFY/WRITE, AND REFRESH CYCLE						
t_{REF}	Time Between Refresh				2	ms
t_{AC}	Address to CE Set-Up Time	t_{AC} is Measured From End of Address Transition	0			ns
t_{AH}	Address Hold Time		50			ns
t_{CC}	CE "OFF" Time		130			ns
t_T	CE Transition Time		10		40	ns
t_{CF}	CE "OFF" to Output High Impedance State		0			ns
t_{TC}	TRI-SHARE Port to CE Set-Up Time		0			ns
t_{TH}	TRI-SHARE Port Hold Time		80			ns
READ CYCLE						
t_{CY}	Cycle Time	$t_T = 20$ ns	470			ns
t_{CE}	CE "ON" Time	$C_{LOAD} = 50$ pF, Load = One TTL Gate	300		3000	ns
t_{CO}	CE Output Delay	Ref 1 = 2.0V, Ref 0 = 0.8V			250	ns
t_{ACC}	Address to Output Access	$t_{ACC} = t_{AC} + t_{CO} + t_T$			270	ns
t_{TL}	CE to TSP		0			ns
WRITE CYCLE						
t_{CY}	Cycle Time		470			ns
t_{CE}	CE "ON" Time		300		3000	ns
t_{WI}	TSP to CE "OFF"		150			ns
t_{CW}	CE to TSP	$t_T = 20$ ns			115	ns
t_D	D_{IN} to CE "OFF"		150			ns
t_{DH}	D_{IN} Hold Time		0			ns
t_{WP}	TSP Pulse Width		50			ns
READ/MODIFY/WRITE CYCLE						
t_{RWC}	Read Modify Write (RMW) Cycle Time		650			ns
t_{CRW}	CE Width During RMW		480		3000	ns
t_{WC}	TSP to CE "ON"	$t_T = 20$ ns	0			ns
t_{W2}	TSP to CE "OFF"	$C_{LOAD} = 50$ pF, Load = One TTL Gate	200			ns
t_{WP}	TSP Pulse Width	Ref 1 - 2.0V, Ref 0 = 0.8V	50			ns
t_D	D_{IN} to CE "OFF"	$t_{ACC} = t_{AC} + t_{CO} + t_T$	150			ns
t_{DH}	D_{IN} Hold Time		0			ns
t_{CO}	CE to Output Delay				180	ns
t_{ACC}	Access Time				270	ns
t_{WD}	TSP to Output High Impedance				250	ns
t_M	Modify Time		0			ns
CAPACITANCE (Note 1)						
C_{AD}	Address Capacitance, $\overline{CS}$	$V_{IN} = V_{SS}$		2		pF
C_{CE}	CE Capacitance	$V_{IN} = V_{SS}$		15		pF
$C_{I/O}$	Data I/O Capacitance	$V_{OUT} = 0V$		8		pF
C_{IN}	TSP Capacitance	$V_{IN} = V_{SS}$		5		pF

Note 1: Capacitance measured with Boonton Meter or effective capacitance calculated from the equation $C = I\Delta t/\Delta V$ with the current equal to a constant 20 mA.

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MOS RAMs
Advance Information

MM5271 TRI-SHARE™ 4096-bit fully TTL compatible dynamic random access read/write memory

general description

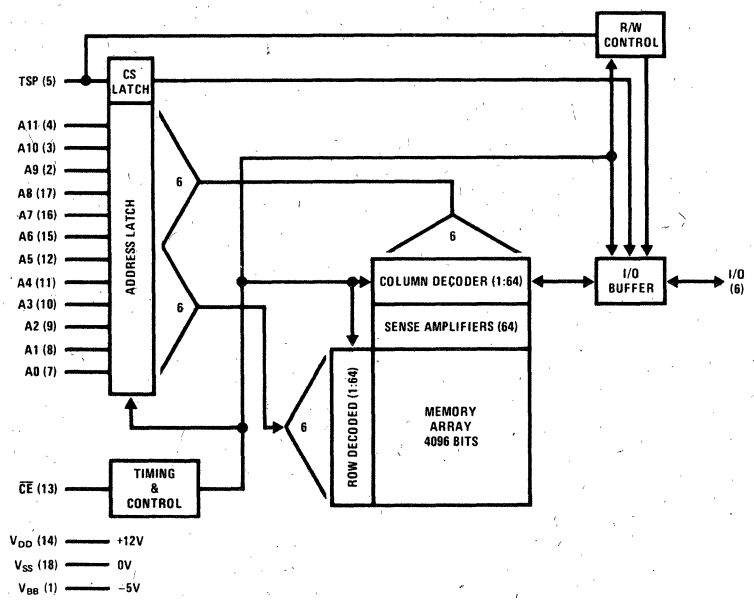
The MM5271 is a fully TTL compatible 4096-bit dynamic random access memory with TRI-SHARE. Because of this unique design feature, National is able to house a 4k device in an 18-pin dual-in-line package. The device is manufactured using N-channel silicon gate technology with a single transistor cell which provides higher density on a monolithic chip and thus lower cost.

The TRI-SHARE Port (TSP) is a multifunction input that, along with a common input/output, allows National to manufacture an 18-pin version of a 4k RAM. The functions controlled by the TSP are read/write, V_{CC}, and logical chip select. In order to understand how the TSP works, consider the timing diagrams. The state of the TSP at the leading edge of the chip enable clock determines whether the device is selected. If it is at a TTL high level, the chip is selected and the device goes into a read mode after chip enable goes high. This high level also controls the V_{CC} function in that it enables a reference voltage for a TTL high output. The supply for the output buffer is V_{DD}, not the TRI-SHARE Port; thus, no special driver is required. In order to perform a write, the TSP must be pulsed low after the minimum hold time and the appropriate data placed on the I/O. When the MM5271 goes into write, the output circuit is disabled. If the TSP is low at the start of the cycle, the memory is not selected but it will be refreshed when the chip enable clock is pulsed.

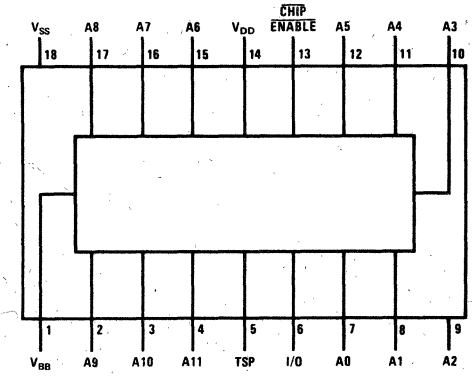
features

- 4096 x 1 bit organization
- Access time 250 ns maximum
- Cycle time 400 ns minimum
- TRI-SHARE port
- High memory density—18-pin package
- TTL compatible inputs
- TRI-STATE® common input/output
- Registers on chip for addresses and chip select
- Two power supplies, +12V, −5V
- Simple read-modify-write operation

block and connection diagrams



Dual-In-Line Package



Order Number MM5271D
See Package 4

Pin Names

A0–A11	Address Inputs*	V_{BB}	Power (−5V)
$\overline{CE}$	Chip Enable	V_{DD}	Power (+12V)
TSP	TRI-SHARE Port	V_{SS}	Ground
I/O	$D_{IN}/\overline{D_{OUT}}$		

*Refresh Addess A0–A5

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absolute maximum ratings (Note 1)

Operating Temperature Range	0°C to +70°C
Storage Temperature	−65°C to +150°C
All Input or Output Voltages with Respect to the Most Negative Supply Voltage, V_{BB}	−0.3V to +25V
Supply Voltages V_{DD} and V_{SS} with Respect to V_{BB}	−0.3V to +20V
Power Dissipation	1.0W

dc electrical characteristics

T_A = 0°C to +70°C, V_{DD} = +12V ±5%, V_{BB} (Note 2) = −5V ±5%, V_{SS} = 0V, unless otherwise noted

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP (3)	MAX	UNITS
I_{LI}	Input Load Current	V_{IN} = 0V to V_{IH} max		0.01	10	μA
$\|I_{LO}\|$	Output Leakage Current Up For High Impedance State	$\overline{CE}$ = V_{IH}, V_O = 0V to 5.25V		0.01	10	μA
I_{DD1}	V_{DD} Supply Current During $\overline{CE}$ "OFF"	$\overline{CE}$ = V_{IH}, (Note 4)		1		mA
I_{DD2}	V_{DD} Supply Current During $\overline{CE}$ "ON"	CE = V_{IL}, T_A = 25°C		20		mA
$I_{DD\ AV1}$	Average V_{DD} Current	T_A = 25°C, Cycle Time = 400 ns, t_{CE} = 240 ns		35		mA
$I_{DD\ AV2}$	Average V_{DD} Current	T_A = 25°C, Cycle Time = 1000 ns, t_{CE} = 240 ns		15		mA
I_{BB}	V_{BB} Supply Current Average			5	100	μA
V_{IL}	Input Low Voltage	t_T = 10 ns, *(Figure 4)*	−1.0		0.6	V
V_{IH}	Input High Voltage		2.4		V_{CC}+1	V
V_{OL}	Output Low Voltage	I_{OL} = 2.0 mA	0.0		0.45	V
V_{OH}	Output High Voltage	I_{OH} = −2.0 mA	2.4			V

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: The only requirement for the sequence of applying voltage to the device is that V_{DD} or V_{SS} should never be 0.3V more negative than V_{BB}.

Note 3: Typical values are for T_A = 25°C and nominal power supply voltages.

Note 4: The I_{DD} current is to V_{SS}. The I_{BB} current is the sum of all leakage currents.

ac electrical characteristics T_A = 0°C to +70°C, V_{DD} = 12V ±5%, V_{BB} = −5V ±5%

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ, WRITE, READ/MODIFY/WRITE, AND REFRESH CYCLE						
t_{REF}	Time Between Refresh				2	ms
t_{AC}	Address to $\overline{CE}$ Set-Up Time	t_{AC} is Measured From End of Address Transition	0			ns
t_{AH}	Address Hold Time		100			ns
t_{CC}	$\overline{CE}$ "OFF" Time		140			ns
t_T	$\overline{CE}$ Transition Time				40	ns
t_{CF}	$\overline{CE}$ "OFF" to Output High Impedance State		50			ns
t_{TC}	TRI-SHARE Port to $\overline{CE}$ Set-Up Time		0			ns
t_{TH}	TRI-SHARE Port Hold Time		100			ns
READ CYCLE						
t_{CY}	Cycle Time	t_T = 10 ns	400			ns
t_{CE}	$\overline{CE}$ "ON" Time	C_{LOAD} = 50 pF, Load = One TTL Gate	240		3000	ns
t_{CO}	$\overline{CE}$ Output Delay	Ref 1 = 2.0V, Ref 0 = 0.8V			250	ns
t_{ACC}	Address to Output Access	t_{ACC} = t_{AC} + t_{CO}			250	ns
t_{TL}	$\overline{CE}$ to TSP		0			ns

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ac electrical characteristics (con't) $T_A = 0°C$ to $+70°C$, $V_{DD} = 12V \pm 5\%$, $V_{BB} = -5V \pm 5\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
WRITE CYCLE						
t_{CY}	Cycle Time		400			ns
t_{CE}	$\overline{CE}$ "ON" Time		240		3000	ns
t_{WI}	TSP to CE "OFF"		100			ns
t_{CW}	$\overline{CE}$ to TSP	$t_T = 10$ ns, (Note 4)			130	ns
t_D	D_{IN} to $\overline{CE}$ "OFF"		70			ns
t_{DH}	D_{IN} Hold Time		50			ns
t_{WP}	TSP Pulse Width		50			ns

ac electrical characteristics (con't) $T_A = 0°C$ to $+70°C$, $V_{DD} = 12V \pm 5\%$, $V_{BB} = -5V \pm 5\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ/MODIFY/WRITE CYCLE						
t_{RWC}	Read Modify Write (RMW) Cycle Time		560			ns
t_{CRW}	$\overline{CE}$ Width During RMW	$t_T = 10$ ns	400		3000	ns
t_{W2}	TSP to $\overline{CE}$ "OFF"	$C_{LOAD} = 50$ pF, Load = One TTL Gate	150			ns
t_{WP}	TSP Pulse Width	Ref 1 - 2.0V, Ref 0 = 0.8V	50			ns
t_D	D_{IN} to $\overline{CE}$ "OFF"	$t_{ACC} = t_{AC} + t_{CO}$	70			ns
t_{DH}	D_{IN} Hold Time		50			ns
t_{CO}	$\overline{CE}$ to Output Delay				250	ns
t_{ACC}	Access Time				250	ns
t_{WD}	TSP to Output High Impedance				50	ns
t_M	Modify Time		0			ns
CAPACITANCE (Note 1)						
C_{AD}	Address Capacitance, $\overline{CS}$	$V_{IN} = V_{SS}$		2		pF
C_{CE}	$\overline{CE}$ Capacitance	$V_{IN} = V_{SS}$		5		pF
$C_{I/O}$	Data I/O Capacitance	$V_{OUT} = 0V$		8		pF
C_{IN}	TSP Capacitance	$V_{IN} = V_{SS}$		5		pF

Note 1: Capacitance measured with Boonton Meter or effective capacitance calculated from the equation $C = I\Delta t/\Delta V$ with the current equal to a constant 20 mA.

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MOS RAMs

MM5280 4096-bit dynamic random access memory

general description

National's MM5280 is a 4096 word by 1 bit dynamic RAM. It incorporates the latest memory design features and can be used in a wide variety of applications, from those which require very high speed to ones where low cost and large bit capacity are the prime criteria.

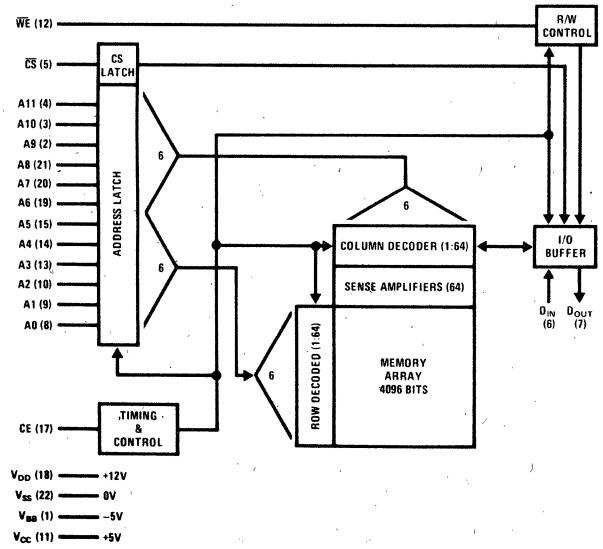
The MM5280 must be refreshed every 2 ms. This can be accomplished by performing a read cycle at each of the 64 row addresses (A0–A5). The chip select input can be either high or low for refresh.

The MM5280 has been designed with minimum production costs as a prime criterion. It is fabricated using N-channel silicon gate MOS technology, which is an ideal choice for high density integrated circuits. The MM5280 uses a single transistor cell to minimize the device area. The single device cell, along with unique design features in the on-chip peripheral circuits, yields a high performance memory device.

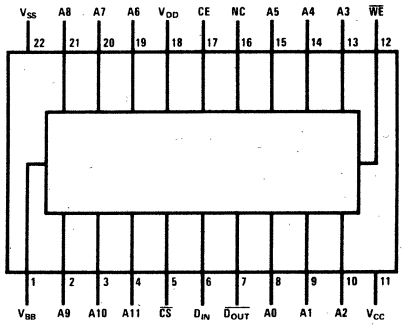
features

- Organization: 4096 x 1
- Access time 200 ns maximum
- Cycle time 400 ns minimum
- Easy system interface
  - One high voltage input—chip enable
  - TTL compatible—all other inputs and output
- Address registers on-chip
- TRI-STATE® output
- Simple read-modify-write operation
- Industry standard pin configuration

block and connection diagrams



Dual-In-Line Package



TOP VIEW

Order Number MM5280D
See Package 5

Pin Names

A0–A11	Address Inputs*	V_{BB}	Power (−5V)
CE	Chip Enable	V_{CC}	Power (+5V)
$\overline{CS}$	Chip Select	V_{DD}	Power (+12V)
D_{IN}	Data Input	V_{SS}	Ground
$\overline{D_{OUT}}$	Data Output	$\overline{WE}$	Write Enable
NC	Not Connected		

*Refresh Address A0–A5

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absolute maximum ratings (Note 1)

Operating Temperature Range	0°C to +70°C	Supply Voltages V_{DD}, V_{CC} and V_{SS} with Respect to V_{BB}	−0.3V to +20V
Storage Temperature	−65°C to +150°C	Power Dissipation	1.25W
All Input or Output Voltages with Respect to the Most Negative Supply Voltage, V_{BB}	−0.3V to +25V		

dc electrical characteristics

T_A = 0°C to +70°C V_{DD} = +12V ±5%, V_{CC} = +5V ±5%, V_{BB} (Note 2) = −5V ±5%, V_{SS} = 0V, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
I_{LI}	Input Load Current	V_{IN} = 0V to V_{IH} max, (All Inputs Except CE)		0.01	10	μA
I_{LC}	Input Load Current	V_{IN} = 0V to V_{IHC} max		0.01	10	μA
$\|I_{LO}\|$	Output Leakage Current Up For High Impedance State	CE = V_{ILC} or $\overline{CS}$ = V_{IH}, V_O = 0V to 5.25V		0.01	10	μA
I_{DD1}	V_{DD} Supply Current During CE "OFF"	CE = −1V to +6V, Note 4		110		μA
I_{DD2}	V_{DD} Supply Current During CE "ON"	CE = V_{IHC}, T_A = 25°C		20		mA
$I_{DD\ AV1}$	Average V_{DD} Current	T_A = 25°C Cycle Time = 400 ns, t_{CE} = 230 ns		35		mA
$I_{DD\ AV2}$	Average V_{DD} Current	T_A = 25°C Cycle Time = 1000 ns, t_{CE} = 230 ns		15		mA
I_{CC1}	V_{CC} Supply Current During CE "OFF"	CE = V_{ILC} or $\overline{CS}$ = V_{IH}, (Note 5)		0.01	10	μA
I_{BB}	V_{BB} Supply Current Average			5	100	μA
V_{IL}	Input Low Voltage	t_T = 20 ns *(Figure 4)*	−1.0		0.6	V
V_{IH}	Input High Voltage		2.4		V_{CC}+1	V
V_{ILC}	CE Input Low Voltage		−1.0		1.0	V
V_{IHC}	CE Input High Voltage		V_{DD}−1		V_{DD}+1	V
V_{OL}	Output Low Voltage	I_{OL} = 2.0 mA	0.0		0.45	V
V_{OH}	Output High Voltage	I_{OH} = −2.0 mA	2.4		V_{CC}	V

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: The only requirement for the sequence of applying voltage to the device is that V_{DD}, V_{CC}, and V_{SS} should never be 0.3V more negative than V_{BB}.

Note 3: Typical values are for T_A = 25°C and nominal power supply voltages.

Note 4: The I_{DD} and I_{CC} currents flow to V_{SS}. The I_{BB} current is the sum of all leakage currents.

Note 5: During CE "ON" V_{CC} supply current is dependent on output loading, V_{CC} is connected to output buffer only.

ac electrical characteristics T_A = 0°C to +70°C, V_{DD} = 12V ±5%, V_{CC} = 5V ±5%, V_{BB} = −5V ±5%

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ, WRITE, READ/MODIFY/WRITE, AND REFRESH CYCLE						
t_{REF}	Time Between Refresh				2	ms
t_{AC}	Address to CE Set-Up Time	t_{AC} is Measured From End of Address Transition	0			ns
t_{AH}	Address Hold Time		50			ns
t_{CC}	CE "OFF" Time		130			ns
t_T	CE Transition Time		10		40	ns
t_{CF}	CE "OFF" to Output High Impedance State		0			ns
READ CYCLE						
t_{CY}	Cycle Time		400			ns
t_{CE}	CE "ON" Time		230		3000	ns
t_{CO}	CE Output Delay	C_{LOAD} = 50 pF, Load = 1 TTL Gate, Ref = 2.0V, $t_{ACC} = t_{AC} + t_{CO} + 1\ t_T$			180	ns
t_{ACC}	Address to Output Access				200	ns
t_{WL}	CE to $\overline{WE}$		0			ns
t_{WC}	$\overline{WE}$ to CE "ON"		0			ns

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ac electrical characteristics (con't)

$T_A = 0°C$ to $+70°C$, $V_{DD} = 12V \pm 5\%$, $V_{CC} = 5V \pm 5\%$, $V_{BB} = -5\% \pm 5\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
WRITE CYCLE						
t_{CY}	Cycle Time		400			ns
t_{CE}	CE "ON" Time		230		3000	ns
t_W	$\overline{WE}$ to CE "OFF"		150			ns
t_{CW}	CE to $\overline{WE}$	$t_T = 20$ ns	100			ns
t_D	D_{IN} to CE Set-Up		150			ns
t_{DH}	D_{IN} Hold Time		0			ns
t_{WP}	$\overline{WE}$ Pulse Width		50			ns

ac electrical characteristics (con't)

$T_A = 0°C$ to $+70°C$, $V_{DD} = 12V \pm 5\%$, $V_{CC} = 5V \pm 5\%$, $V_{BB} = -5\% \pm 5\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ/MODIFY/WRITE CYCLE						
t_{RWC}	Read Modify Write (RMW) Cycle Time		520			ns
t_{CRW}	CE Width During RMW		350		3000	ns
t_{WC}	$\overline{WE}$ to CE "ON"		0			ns
t_W	$\overline{WE}$ to CE "OFF"		150			ns
t_{WP}	$\overline{WE}$ Pulse Width	$t_T = 20$ ns, $C_{LOAD} = 50$ pF, Load = 1 TTL Gate, Ref = 2.0V, $t_{ACC} = t_{AC} + t_{CO} + 1\,t_T$	50			ns
t_D	D_{IN} to CE Set-Up		150			ns
t_{DH}	D_{IN} Hold Time		0			ns
t_{CO}	CE to Output Delay				180	ns
t_{WO}	$\overline{WE}$ to $\overline{D_{OUT}}$ Invalid		0			
t_{ACC}	Access Time				200	ns
CAPACITANCE (Note 1)		$T_A = 25°C$				
C_{AD}	Address Capacitance, $\overline{CS}$	$V_{IN} = V_{SS}$		2		pF
C_{CE}	CE Capacitance	$V_{IN} = V_{SS}$		15		pF
C_{OUT}	Data Output Capacitance	$V_{OUT} = 0V$		5		pF
C_{IN}	D_{IN} and $\overline{WE}$ Capacitance	$V_{IN} = V_{SS}$		4		pF

Note 1: Capacitance measured with Boonton Meter or effective capacitance calculated from the equation $C = I\Delta t/\Delta V$ with the current equal to a constant 20 mA.

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MM5280A 4096-bit dynamic random access memory

general description

National's MM5280A is a 4096 word by 1 bit dynamic RAM. It incorporates the latest memory design features and can be used in a wide variety of applications, from those which require very high speed to ones where low cost and large bit capacity are the prime criteria.

The RAM must be refreshed every 2 ms. This can be accomplished by performing a cycle at each of the 64 row addresses (A0–A5).

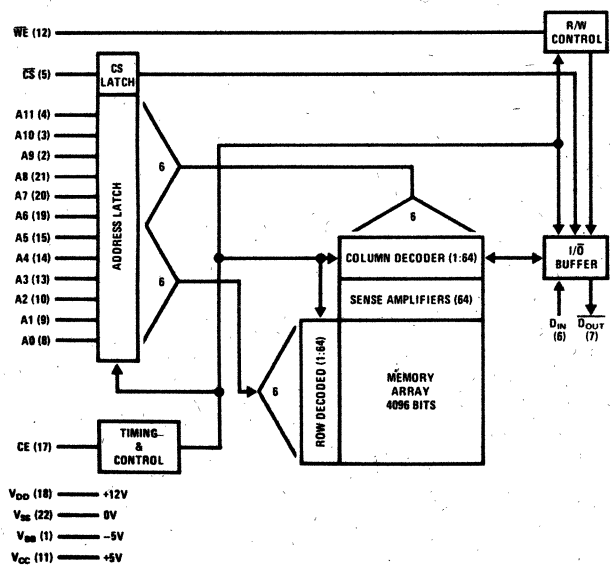
Addresses (A6–A11) must have a stable address during the refresh cycle. Any address is satisfactory as long as the address set-up and hold times are met. The chip select input can be either high or low for refresh.

The MM5280A has been designed with minimum production costs as a prime criterion. It is fabricated using N-channel silicon gate MOS technology, which is an ideal choice for high density integrated circuits. The MM5280A uses a single transistor cell to minimize the device area. The single device cell, along with unique design features in the on-chip peripheral circuits, yields a high performance memory device.

features

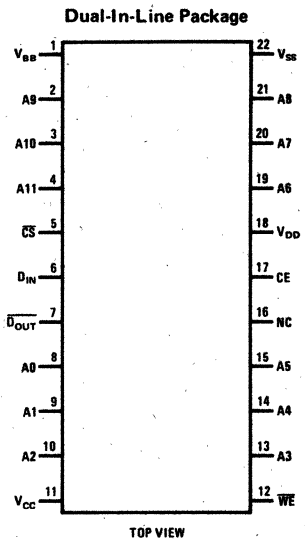
- Organization: 4096 x 1
- Access time—150 ns max
- Cycle time—300 ns min
- Easy system interface
  - One high voltage input—chip enable
  - TTL compatible—all other inputs and output
- Address registers on-chip
- TRI-STATE® output
- Simple read-modify-write operation
- Industry standard pin configuration

block diagram

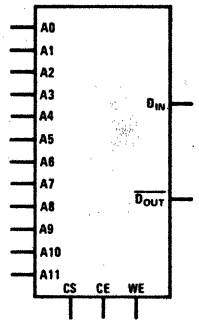


Memory inverts from Data In to Data Out.

connection diagram



logic symbol



Pin Names

*A0–A11	Address Inputs	V_{BB}	Power (−5V)
CE	Chip Enable	V_{CC}	Power (+5V)
$\overline{CS}$	Chip Select	V_{DD}	Power (+12V)
D_{IN}	Data Input	V_{SS}	Ground
$\overline{D_{OUT}}$	Data Output	$\overline{WE}$	Write Enable
NC	Not Connected		

*Row address A0–A5

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absolute maximum ratings

Operating Temperature Range	0°C to +70°C	Voltage on Any Pin Relative to V_{BB} ($V_{SS} - V_{BB} \geq 4.5V$)	−0.3V to +20V
Storage Temperature	−65°C to +150°C		
Power Dissipation	1.25W	Lead Temperature (Soldering, 10 seconds)	300°C

dc electrical characteristics

$T_A = 0°C$ to $+70°C$ $V_{DD} = +12V \pm 5\%$, $V_{CC} = +5V \pm 5\%$, V_{BB} (Note 2) $= -5V \pm 5\%$, $V_{SS} = 0V$, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
I_{LI}	Input Load Current	$V_{IN} = 0V$ to V_{IH} max, (All Inputs Except CE)		0.01	10	μA
I_{LC}	Input Load Current	$V_{IN} = 0V$ to V_{IHC} max		0.01	10	μA
$\|I_{LO}\|$	Output Leakage Current Up For High Impedance State	CE = V_{ILC} or $\overline{CS} = V_{IH}$, $V_O = 0V$ to 5.25V		0.01	10	μA
I_{DD1}	V_{DD} Supply Current During CE "OFF"	CE = −1V to +6V, Note 4		110		μA
I_{DD2}	V_{DD} Supply Current During CE "ON"	CE = V_{IHC}, $T_A = 25°C$		20		mA
$I_{DD\ AV1}$	Average V_{DD} Current	$T_A = 25°C$ Cycle Time = 300 ns, t_{CE} = 160 ns		45		mA
$I_{DD\ AV2}$	Average V_{DD} Current	$T_A = 25°C$ Cycle Time = 1000 ns, t_{CE} = 160 ns		15		mA
I_{CC1}	V_{CC} Supply Current During CE "OFF"	CE = V_{ILC} or $\overline{CS} = V_{IH}$, (Note 5)		0.01	10	μA
I_{BB}	V_{BB} Supply Current Average			5	100	μA
V_{IL}	Input Low Voltage	t_T = 20 ns *(Figure 4)*	−1.0		0.6	V
V_{IH}	Input High Voltage		2.4		$V_{CC}+1$	V
V_{ILC}	CE Input Low Voltage		−1.0		1.0	V
V_{IHC}	CE Input High Voltage		$V_{DD}-1$		$V_{DD}+1$	V
V_{OL}	Output Low Voltage	I_{OL} = 2.0 mA	0.0		0.45	V
V_{OH}	Output High Voltage	I_{OH} = −2.0 mA	2.4		V_{CC}	V

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: All voltages referenced to V_{SS}. V_{BB} must be applied before and removed after other supply voltages.

Note 3: Typical values are for $T_A = 25°C$ and nominal power supply voltages.

Note 4: The I_{DD} and I_{CC} currents flow to V_{SS}. The I_{BB} current is the sum of all leakage currents.

Note 5: During CE "ON" V_{CC} supply current is dependent on output loading, V_{CC} is connected to output buffer only.

ac electrical characteristics $T_A = 0°C$ to $+70°C$, $V_{DD} = 12V \pm 5\%$, $V_{CC} = 5V \pm 5\%$, $V_{BB} = -5V \pm 5\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ, WRITE, READ/MODIFY/WRITE, AND REFRESH CYCLE						
t_{REF}	Time Between Refresh				2	ms
t_{AC}	Address to CE Set-Up Time	t_{AC} is Measured From End of Address Transition	0			ns
t_{AH}	Address Hold Time		40			ns
t_{CC}	CE "OFF" Time		100			ns
t_T	CE Transition Time		10		40	ns
t_{CF}	CE "OFF" to Output High Impedance State		0			ns
READ CYCLE						
t_{CY}	Cycle Time		300			ns
t_{CE}	CE "ON" Time		160		3000	ns
t_{CO}	CE Output Delay	C_{LOAD} = 50 pF, Load = 1 TTL Gate, Ref = 2.0V, $t_{ACC} = t_{AC} + t_{CO} + 1\ t_T$			130	ns
t_{ACC}	Address to Output Access				150	ns
t_{WL}	CE to $\overline{WE}$		0			ns
t_{WC}	$\overline{WE}$ to CE "ON"		0			ns

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ac electrical characteristics (con't)

$T_A = 0°C$ to $+70°C$, $V_{DD} = 12V \pm 5\%$, $V_{CC} = 5V \pm 5\%$, $V_{BB} = -5\% \pm 5\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
WRITE CYCLE						
t_{CY}	Cycle Time		300			ns
t_{CE}	CE "ON" Time		160		3000	ns
t_W	$\overline{WE}$ to CE "OFF"		80			ns
t_{CW}	CE to $\overline{WE}$	$t_T = 20$ ns	80			ns
t_D	D_{IN} to CE Set-Up		80			ns
t_{DH}	D_{IN} Hold Time		0			ns
t_{WP}	$\overline{WE}$ Pulse Width		50			ns

ac electrical characteristics (con't) $T_A = 0°C$ to $+70°C$, $V_{DD} = 12V \pm 5\%$, $V_{CC} = 5V \pm 5\%$, $V_{BB} = -5\% \pm 5\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ/MODIFY/WRITE CYCLE						
t_{RWC}	Read Modify Write (RMW) Cycle Time		370			ns
t_{CRW}	CE Width During RMW		230		3000	ns
t_{WC}	$\overline{WE}$ to CE "ON"		0			ns
t_W	$\overline{WE}$ to CE "OFF"		80			ns
t_{WP}	$\overline{WE}$ Pulse Width	$t_T = 20$ ns, $C_{LOAD} = 50$ pF, Load = 1 TTL Gate, Ref = 2.0V, $t_{ACC} = t_{AC} + t_{CO} + 1\ t_T$	50			ns
t_D	D_{IN} to CE Set-Up		80			ns
t_{DH}	D_{IN} Hold Time		0			ns
t_{CO}	CE to Output Delay				130	ns
t_{WO}	$\overline{WE}$ to $\overline{D_{OUT}}$ Invalid		0			
t_{ACC}	Access Time				150	ns
CAPACITANCE (Note 1)		$T_A = 25°C$				
C_{AD}	Address Capacitance, $\overline{CS}$	$V_{IN} = V_{SS}$		2		pF
C_{CE}	CE Capacitance	$V_{IN} = V_{SS}$		15		pF
C_{OUT}	Data Output Capacitance	$V_{OUT} = 0V$		5		pF
C_{IN}	D_{IN} and $\overline{WE}$ Capacitance	$V_{IN} = V_{SS}$		4		pF

Note 1: Capacitance measured with Boonton Meter or effective capacitance calculated from the equation $C = I\Delta t/\Delta V$ with the current equal to a constant 20 mA.

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MOS RAMs

MM5280-5 4096-bit dynamic random access read/write memory

general description

The MM5280-5 is a slower speed version of National's MM5280. Please refer to the MM5280 specification for pin configuration, block diagram and switching time waveforms.

features

- Access time—270 ns
- Cycle time—470 ns

absolute maximum ratings (Note 1)

Operating Temperature Range	0°C to +70°C
Storage Temperature	−65°C to +150°C
All Input or Output Voltages with Respect to the Most Negative Supply Voltage, V_{BB}	−0.3V to +25V
Supply Voltages V_{DD}, V_{CC} and V_{SS} with Respect to V_{BB}	−0.3V to +20V
Power Dissipation	1.25W

Order Number MM5280D-5
See Package 5

dc electrical characteristics

T_A = 0°C to +70°C V_{DD} = +12V ±5%, V_{CC} = +5V ±5%, V_{BB} (Note 2) = −5V ±5%, V_{SS} = 0V, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
I_{LI}	Input Load Current	V_{IN} = 0V to V_{IH} max, (All Inputs Except CE)		0.01	10	μA
I_{LC}	Input Load Current	V_{IN} = 0V to V_{IHC} max		0.01	10	μA
$\|I_{LO}\|$	Output Leakage Current Up For High Impedance State	CE = V_{ILC} or $\overline{CS}$ = V_{IH}, V_O = 0V to 5.25V		0.01	10	μA
I_{DD1}	V_{DD} Supply Current During CE "OFF"	CE = −1V to +6V, Note 4		110		μA
I_{DD2}	V_{DD} Supply Current During CE "ON"	CE = V_{IHC}, T_A = 25°C		20		mA
$I_{DD\ AV1}$	Average V_{DD} Current	T_A = 25°C Cycle Time = 400 ns, t_{CE} = 230 ns		35		mA
$I_{DD\ AV2}$	Average V_{DD} Current	T_A = 25°C Cycle Time = 1000 ns, t_{CE} = 230 ns		15		mA
I_{CC1}	V_{CC} Supply Current During CE "OFF"	CE = V_{ILC} or $\overline{CS}$ = V_{IH}, (Note 5)		0.01	10	μA
I_{BB}	V_{BB} Supply Current Average			5	100	μA
V_{IL}	Input Low Voltage	t_T = 20 ns	−1.0		0.6	V
V_{IH}	Input High Voltage		2.4		V_{CC}+1	V
V_{ILC}	CE Input Low Voltage		−1.0		1.0	V
V_{IHC}	CE Input High Voltage		V_{DD}−1		V_{DD}+1	V
V_{OL}	Output Low Voltage	I_{OL} = 2.0 mA	0.0		0.45	V
V_{OH}	Output High Voltage	I_{OH} = −2.0 mA	2.4		V_{CC}	V

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: The only requirement for the sequence of applying voltage to the device is that V_{DD}, V_{CC}, and V_{SS} should never be 0.3V more negative than V_{BB}.

Note 3: Typical values are for T_A = 25°C and nominal power supply voltages.

Note 4: The I_{DD} and I_{CC} currents flow to V_{SS}. The I_{BB} current is the sum of all leakage currents.

Note 5: During CE "ON" V_{CC} supply current is dependent on output loading, V_{CC} is connected to output buffer only.

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ac electrical characteristics

$T_A = 0°C$ to $+70°C$, $V_{DD} = 12V \pm 5\%$, $V_{CC} = 5V \pm 5\%$, $V_{BB} = -5V \pm 5\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ, WRITE, READ/MODIFY/WRITE, AND REFRESH CYCLE						
t_{REF}	Time Between Refresh				2	ms
t_{AC}	Address to CE Set-Up Time	t_{AC} is Measured From End of Address Transition	0			ns
t_{AH}	Address Hold Time		50			ns
t_{CC}	CE "OFF" Time		130			ns
t_T	CE Transition Time		10		40	ns
t_{CF}	CE "OFF" to Output High Impedance State		0			ns
READ CYCLE						
t_{CY}	Cycle Time		470			ns
t_{CE}	CE "ON" Time		300		3000	ns
t_{CO}	CE Output Delay	C_{LOAD} = 50 pF, Load = 1 TTL Gate, Ref = 2.0V, $t_{ACC} = t_{AC} + t_{CO} + 1\,t_T$			250	ns
t_{ACC}	Address to Output Access				270	ns
t_{WL}	CE to $\overline{WE}$		0			ns
t_{WC}	$\overline{WE}$ to CE "ON"		0			ns
WRITE CYCLE						
t_{CY}	Cycle Time		470			ns
t_{CE}	CE "ON" Time		300		3000	ns
t_W	$\overline{WE}$ to CE "OFF"		150			ns
t_{CW}	CE to $\overline{WE}$	t_T = 20 ns	130			ns
t_D	D_{IN} to CE Set-Up		150			ns
t_{DH}	D_{IN} Hold Time		0			ns
t_{WP}	$\overline{WE}$ Pulse Width		50			ns
READ/MODIFY/WRITE CYCLE						
t_{RWC}	Read Modify Write (RMW) Cycle Time		590			ns
t_{CRW}	CE Width During RMW		420		3000	ns
t_{WC}	$\overline{WE}$ to CE "ON"		0			ns
t_W	$\overline{WE}$ to CE "OFF"		150			ns
t_{WP}	$\overline{WE}$ Pulse Width	t_T = 20 ns, C_{LOAD} = 50 pF, Load = 1 TTL Gate, Ref = 2.0V, $t_{ACC} = t_{AC} + t_{CO} + 1\,t_T$	50			ns
t_D	D_{IN} to CE Set-Up		150			ns
t_{DH}	D_{IN} Hold Time		0			ns
t_{CO}	CE to Output Delay				250	ns
t_{WO}	$\overline{WE}$ to $\overline{D_{OUT}}$ Invalid		0			
t_{ACC}	Access Time				270	ns
CAPACITANCE (Note 1)		$T_A = 25°C$				
C_{AD}	Address Capacitance, $\overline{CS}$	$V_{IN} = V_{SS}$		2		pF
C_{CE}	CE Capacitance	$V_{IN} = V_{SS}$		15		pF
C_{OUT}	Data Output Capacitance	$V_{OUT} = 0V$		5		pF
C_{IN}	D_{IN} and $\overline{WE}$ Capacitance	$V_{IN} = V_{SS}$		4		pF

Note 1: Capacitance measured with Boonton Meter or effective capacitance calculated from the equation $C = I\Delta t/\Delta V$ with the current equal to a constant 20 mA.

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MOS RAMs
Advance Information

MM5281 4096-bit fully TTL compatible dynamic random access memory

general description

National's MM5281 is a 4096 word by 1 bit fully TTL compatible dynamic RAM. It incorporates the latest memory design features and can be used in a wide variety of applications, from those which require very high speed to ones where low cost and large bit capacity are the prime criteria.

The MM5281 must be refreshed every 2 ms. This can be accomplished by performing a read cycle at each of the 64 row addresses (A0–A5). The chip select input can be either high or low for refresh.

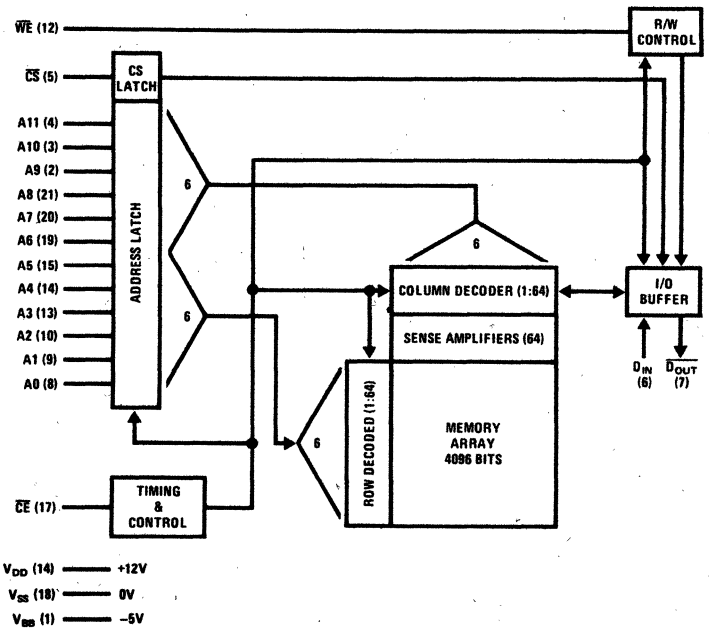
The MM5281 has been designed with minimum production costs as a prime criterion. It is fabricated using N-channel silicon gate MOS technology, which is an ideal choice for high density integrated circuits. The MM5281 uses a single transistor cell to minimize the device area.

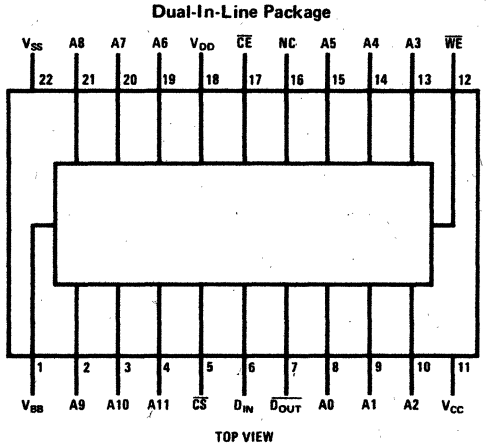
The single device cell, along with unique design features in the on-chip peripheral circuits, yields a high performance memory device.

features

- Organization: 4096 x 1
- Access time 250 ns maximum
- Cycle time 400 ns minimum
- TTL compatible
- Address registers on-chip
- TRI-STATE® output
- Simple read-modify-write operation
- Industry standard pin configuration

block and connection diagrams





Order Number MM5281D
See Package 5

Pin Names

A0–A11	Address Inputs*	V_{BB}	Power (−5V)
$\overline{CE}$	Chip Enable	V_{CC}	Power (+5V)
$\overline{CS}$	Chip Select	V_{DD}	Power (+12V)
D_{IN}	Data Input	V_{SS}	Ground
$\overline{D_{OUT}}$	Data Output	$\overline{WE}$	Write Enable
NC	Not Connected		

*Refresh Address A0–A5

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absolute maximum ratings (Note 1)

Operating Temperature Range	0°C to +70°C	Supply Voltages V_{DD}, V_{CC} and V_{SS} with Respect to V_{BB}	−0.3V to +20V
Storage Temperature	−65°C to +150°C		
All Input or Output Voltages with Respect to the Most Negative Supply Voltage, V_{BB}	−0.3V to +25V	Power Dissipation	1.25W

dc electrical characteristics

T_A = 0°C to +70°C V_{DD} = +12V ±5%, V_{CC} = +5V ±5%, V_{BB} (Note 2) = −5V ±5%, V_{SS} = 0V, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
I_{LI}	Input Load Current	V_{IN} = 0V to V_{IH} max		0.01	10	μA
$\|I_{LO}\|$	Output Leakage Current Up For High Impedance State	$\overline{CE}$ = V_{IH} or $\overline{CS}$ = V_{IH}, V_O = 0V to 5.25V		0.01	10	μA
I_{DD1}	V_{DD} Supply Current During $\overline{CE}$ "OFF"	$\overline{CE}$ = V_{IH}		1		mA
I_{DD2}	V_{DD} Supply Current During $\overline{CE}$ "ON"	$\overline{CE}$ = V_{IL}, T_A = 25°C		20		mA
$I_{DD\,AV1}$	Average V_{DD} Current	T_A = 25°C Cycle Time = 400 ns, t_{CE} = 240 ns		35		mA
$I_{DD\,AV2}$	Average V_{DD} Current	Cycle Time = 1000 ns, t_{CE} = 240 ns		15		mA
I_{CC1}	V_{CC} Supply Current During CE "OFF"	$\overline{CE}$ = V_{IH} or $\overline{CS}$ = V_{IH}, (Note 5)		0.01	10	μA
I_{BB}	V_{BB} Supply Current Average			5	100	μA
V_{IL}	Input Low Voltage	t_T = 10 ns *(Figure 4)*	−1.0		0.6	V
V_{IH}	Input High Voltage		2.4		V_{CC}+1	V
V_{OL}	Output Low Voltage	I_{OL} = 2.0 mA	0.0		0.45	V
V_{OH}	Output High Voltage	I_{OH} = −2.0 mA	2.4		V_{CC}	V

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: The only requirement for the sequence of applying voltage to the device is that V_{DD}, V_{CC}, and V_{SS} should never be 0.3V more negative than V_{BB}.

Note 3: Typical values are for T_A = 25°C and nominal power supply voltages.

Note 4: The I_{DD} and I_{CC} currents flow to V_{SS}. The I_{BB} current is the sum of all leakage currents.

Note 5: During $\overline{CE}$ "ON" V_{CC} supply current is dependent on output loading, V_{CC} is connected to output buffer only.

ac electrical characteristics T_A = 0°C to +70°C, V_{DD} = 12V ±5%, V_{CC} = 5V ±5%, V_{BB} = −5V ±5%

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ, WRITE, READ/MODIFY/WRITE, AND REFRESH CYCLE						
t_{REF}	Time Between Refresh				2	ms
t_{AC}	Address to $\overline{CE}$ Set-Up Time	t_{AC} is Measured From End of Address Transition	0			ns
t_{AH}	Address Hold Time		100			ns
t_{CC}	$\overline{CE}$ "OFF" Time		140			ns
t_T	$\overline{CE}$ Transition Time				40	ns
t_{CF}	$\overline{CE}$ "OFF" to Output High Impedance State		50			ns
READ CYCLE						
t_{CY}	Cycle Time		400			ns
t_{CE}	$\overline{CE}$ "ON" Time		240		3000	ns
t_{CO}	$\overline{CE}$ Output Delay	C_{LOAD} = 50 pF, Load = 1 TTL Gate, Ref = 2.0V, t_{ACC} = t_{AC} + t_{CO}			250	ns
t_{ACC}	Address to Output Access				250	ns
t_{WL}	$\overline{CE}$ to $\overline{WE}$		0			ns
t_{WC}	$\overline{WE}$ to $\overline{CE}$ "ON"		0			ns

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ac electrical characteristics (con't)

$T_A = 0°C$ to $+70°C$, $V_{DD} = 12V \pm 5\%$, $V_{CC} = 5V \pm 5\%$, $V_{BB} = -5\% \pm 5\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
WRITE CYCLE						
t_{CY}	Cycle Time		400			ns
t_{CE}	$\overline{CE}$ "ON" Time		240		3000	ns
t_W	$\overline{WE}$ to $\overline{CE}$ "OFF"		100			ns
t_{CW}	$\overline{CE}$ to $\overline{WE}$	$t_T = 10$ ns	150			ns
t_D	D_{IN} to $\overline{CE}$ Set-Up		100			ns
t_{DH}	D_{IN} Hold Time		50			ns
t_{WP}	$\overline{WE}$ Pulse Width		50			ns

ac electrical characteristics (con't)

$T_A = 0°C$ to $+70°C$, $V_{DD} = 12V \pm 5\%$, $V_{CC} = 5V \pm 5\%$, $V_{BB} = -5\% \pm 5\%$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
READ/MODIFY/WRITE CYCLE						
t_{RWC}	Read Modify Write (RMW) Cycle Time		510			ns
t_{CRW}	$\overline{CE}$ Width During RMW		350		3000	ns
t_{WC}	$\overline{WE}$ to $\overline{CE}$ "ON"		0			ns
t_W	$\overline{WE}$ to $\overline{CE}$ "OFF"	$t_T = 10$ ns, $C_{LOAD} = 50$ pF, Load = 1 TTL Gate, Ref = 2.0V, $t_{ACC} = t_{AC} + t_{CO}$	100			ns
t_{WP}	$\overline{WE}$ Pulse Width		50			ns
t_D	D_{IN} to $\overline{CE}$ Set-Up		100			ns
t_{DH}	D_{IN} Hold Time		50			ns
t_{CO}	$\overline{CE}$ to Output Delay				250	ns
t_{WO}	$\overline{WE}$ to $\overline{D_{OUT}}$ Invalid		0			
t_{ACC}	Access Time				250	ns
CAPACITANCE (Note 1)		$T_A = 25°C$				
C_{AD}	Address Capacitance, $\overline{CS}$	$V_{IN} = V_{SS}$		2		pF
C_{CE}	$\overline{CE}$ Capacitance	$V_{IN} = V_{SS}$		5		pF
C_{OUT}	Data Output Capacitance	$V_{OUT} = 0V$		5		pF
C_{IN}	D_{IN} and $\overline{WE}$ Capacitance	$V_{IN} = V_{SS}$		4		pF

Note 1: Capacitance measured with Boonton Meter or effective capacitance calculated from the equation $C = I\Delta t/\Delta V$ with the current equal to a constant 20 mA.

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CMOS RAMs

MM54C89/MM74C89 64-bit TRI-STATE® random access read/write memory

general description

The MM54C89/MM74C89 is a 16-word by 4-bit random access read/write memory. Inputs to the memory consist of four address lines, four data input lines, a write enable line and a memory enable line. The four binary address inputs are decoded internally to select each of the 16 possible word locations. An internal address register, latches the address information on the positive to negative transition of the memory enable input. The four TRI-STATE® data output lines working in conjunction with the memory enable input provides for easy memory expansion.

Address Operation: Address inputs must be stable t_{SA} prior to the positive to negative transition of memory enable. It is thus not necessary to hold address information stable for more than t_{HA} after the memory is enabled (positive to negative transition of memory enable).

Note: The timing is different than the DM7489 in that a positive to negative transition of the memory enable must occur for the memory to be selected.

Write Operation: Information present at the data inputs is written into the memory at the selected address by bringing write enable and memory enable low.

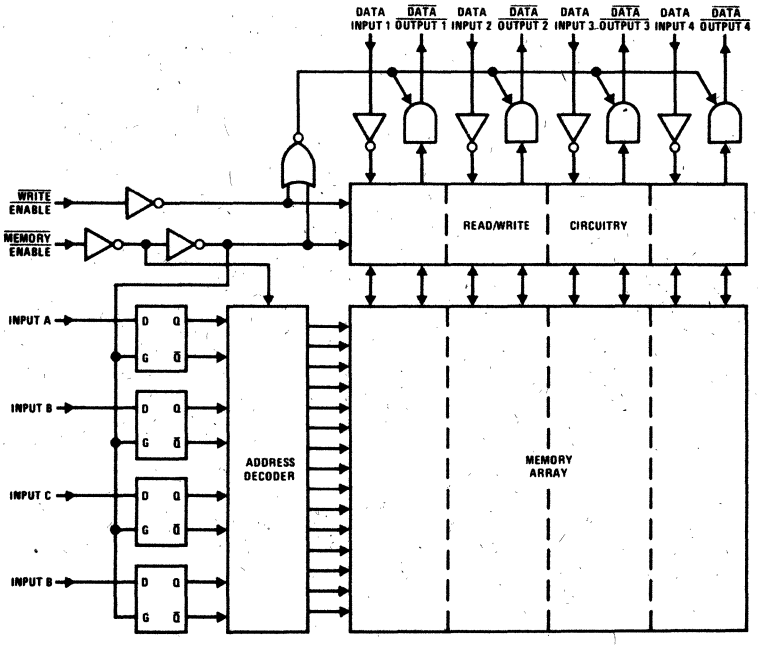
Read Operation: The complement of the information which was written into the memory is non-destructively read out at the four outputs. This is accomplished by selecting the desired address and bringing memory enable low and write enable high.

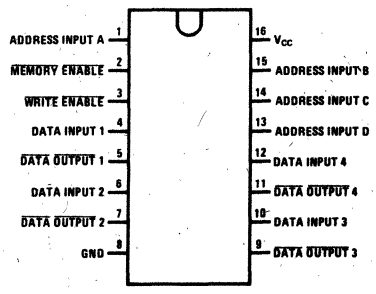
When the device is writing or disabled the output assumes a TRI-STATE (Hi-z) condition.

features

- Wide supply voltage range — 3.0V to 15V
- Guaranteed noise margin — 1.0V
- High noise immunity — 0.45 V_{CC} typ
- Low power TTL compatibility — fan out of 2 driving 74L
- Input address register
- Low power consumption — 100 nW/package typ @ V_{CC} = 5V
- Fast access time — 130 ns typ at V_{CC} = 10V
- TRI-STATE output

logic and connection diagrams





TOP VIEW

Order Number MM54C89D or MM74C89D
See Package 3
Order Number MM74C89N
See Package 15

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absolute maximum ratings

Voltage at Any Pin	−0.3V to V_{CC} + 0.3V
Operating Temperature Range	
MM54C89	−55°C to +125°C
MM74C89	−40°C to +85°C
Storage Temperature Range	−65°C to +150°C
Package Dissipation	500 mW
Operating V_{CC} Range	3.0V to 15V
Absolute Maximum V_{CC}	16V
Lead Temperature (Soldering, 10 seconds)	300°C

dc electrical characteristics

Min/max limits apply across temperature range, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
CMOS TO CMOS					
Logical "1" Input Voltage ($V_{IN(1)}$)	V_{CC} = 5.0V V_{CC} = 10V	3.5 8.0			V V
Logical "0" Input Voltage ($V_{IN(0)}$)	V_{CC} = 5.0V V_{CC} = 10V			1.5 2.0	V V
Logical "1" Output Voltage ($V_{OUT(1)}$)	V_{CC} = 5.0V, I_O = −10μA V_{CC} = 10V, I_O = −10μA	4.5 9.0			V V
Logical "0" Output Voltage ($V_{OUT(0)}$)	V_{CC} = 5.0V, I_O = +10μA V_{CC} = 10V, I_O = +10μA			0.5 1.0	V V
Logical "1" Input Current ($I_{IN(1)}$)	V_{CC} = 15V, V_{IN} = 15V		0.005	1.0	μA
Logical "0" Input Current ($I_{IN(0)}$)	V_{CC} = 15V, V_{IN} = 0V	−1.0	−0.005		μA
Output Current in High Impedance State	V_{CC} = 15V, V_O = 15V V_{CC} = 15V, V_O = 0V	 −1.0	0.005 −0.005	1.0	μA μA
Supply Current (I_{CC})	V_{CC} = 15V		0.05	300	μA
CMOS/LPTTL INTERFACE					
Logical "1" Input Voltage ($V_{IN(1)}$)	54C, V_{CC} = 4.5V 74C, V_{CC} = 4.75V	V_{CC} − 1.5 V_{CC} − 1.5			V V
Logical "0" Input Voltage ($V_{IN(0)}$)	54C, V_{CC} = 4.5V 74C, V_{CC} = 4.75V			0.8 0.8	V V
Logical "1" Output Voltage ($V_{OUT(1)}$)	54C, V_{CC} = 4.5V, I_O = −360μA 74C, V_{CC} = 4.75V, I_O = −360μA	2.4 2.4			V V
Logical "0" Output Voltage ($V_{OUT(0)}$)	54C, V_{CC} = 4.5V, I_O = +360μA 74C, V_{CC} = 4.75V, I_O = +360μA			0.4 0.4	V V
OUTPUT DRIVE (See 54C/74C Family Characteristics Data Sheet)					
Output Source Current (I_{SOURCE}) (P-Channel)	V_{CC} = 5.0V, V_{OUT} = 0V T_A = 25°C	−1.75	−3.3		mA
Output Source Current (I_{SOURCE}) (P-Channel)	V_{CC} = 10V, V_{OUT} = 0V T_A = 25°C	−8.0	−15		mA
Output Sink Current (I_{SINK}) (N-Channel)	V_{CC} = 5.0V, V_{OUT} = V_{CC} T_A = 25°C	1.75	3.6		mA
Output Sink Current (I_{SINK}) (N-Channel)	V_{CC} = 10V, V_{OUT} = V_{CC} T_A = 25°C	8.0	16		mA

ac electrical characteristics (T_A = 25°C, C_L = 50 pF, unless otherwise noted.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Propagation Delay from $\overline{\text{Memory Enable}}$ (t_{pd})	V_{CC} = 5.0V V_{CC} = 10V		270 100	500 220	ns ns
Access Time from Address Input (t_{acc})	V_{CC} = 5.0V V_{CC} = 10V		350 130	650 280	ns ns
Address Input Setup Time (t_{SA})	V_{CC} = 5.0V V_{CC} = 10V	150 60			ns ns
Address Input Hold Time (t_{HA})	V_{CC} = 5.0V V_{CC} = 10V	60 40			ns ns
$\overline{\text{Memory Enable}}$ Pulse Width (t_{ME})	V_{CC} = 5.0V V_{CC} = 10V	400 150	250 90		ns ns
$\overline{\text{Memory Enable}}$ Pulse Width ($t_{\overline{ME}}$)	V_{CC} = 5.0V V_{CC} = 10V	400 150	200 70		ns ns

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ac electrical characteristics (con't)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
$\overline{\text{Write}}$ $\overline{\text{Enable}}$ Setup Time for a Read (t_{SR})	V_{CC} = 5.0V	0			ns
	V_{CC} = 10V	0			ns
$\overline{\text{Write}}$ $\overline{\text{Enable}}$ Setup Time for a Write (t_{WS})	V_{CC} = 5.0V			t_{ME}	ns
	V_{CC} = 10V			t_{ME}	ns
$\overline{\text{Write}}$ $\overline{\text{Enable}}$ Pulse Width ($t_{\overline{WE}}$)	V_{CC} = 5.0V, t_{WS} = 0	300	160		ns
	V_{CC} = 10V, t_{WS} = 0	100	60		ns
Data Input Hold Time (t_{HD})	V_{CC} = 5.0V	50			ns
	V_{CC} = 10V	25			ns
Data Input Setup (t_{SD})	V_{CC} = 5.0V	50			ns
	V_{CC} = 10V	25			ns
Propagation Delay from a Logical "1" or Logical "0" to the High Impedance State from $\overline{\text{Memory}}$ $\overline{\text{Enable}}$ (t_{1H}, t_{0H})	V_{CC} = 5.0V, C_L = 5.0 pF, R_L = 10k		180	300	ns
	V_{CC} = 10V, C_L = 5.0 pF, R_L = 10k		85	120	ns
Propagation Delay from a Logical "1" or Logical "0" to the High Impedance State from $\overline{\text{Write}}$ $\overline{\text{Enable}}$ (t_{1H}, t_{0H})	V_{CC} = 5.0V, C_L = 5.0 pF, R_L = 10k		180	300	ns
	V_{CC} = 10V, C_L = 5.0 pF, R_L = 10k		85	120	ns
Input Capacity (C_{IN})	Any Input (Note 2)		5.0		pF
Output Capacity (C_{OUT})	Any Output (Note 2)		6.5		pF
Power Dissipation Capacity (C_{pd})	(Note 3)		230		pF

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

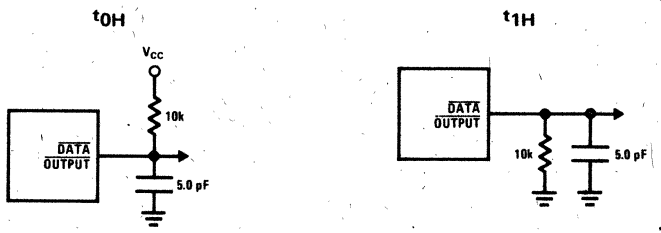
Note 2: Capacitance is guaranteed by periodic testing.

Note 3: C_{PD} determines the no load ac power consumption of any CMOS device. For complete explanation see 54C/74C Family Characteristics application note, AN-90.

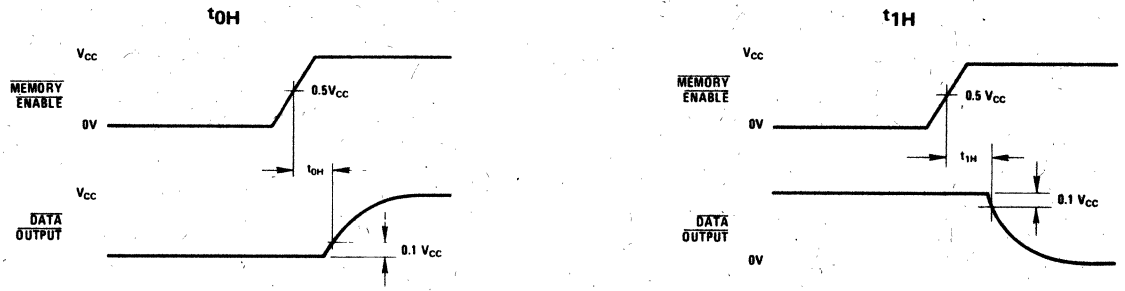
truth table

ME	WE	OPERATION	CONDITION OF OUTPUTS
L	L	Write	TRI-STATE
L	H	Read	Complement of Selected Word
H	L	Inhibit, Storage	TRI-STATE
H	H	Inhibit, Storage	TRI-STATE

ac test circuits



switching time waveforms



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CMOS RAMs

MM54C200/MM74C200 256-bit TRI-STATE® random access read/write memory

general description

The MM54C200/MM74C200 is a 256-bit random access read/write memory. Inputs consist of eight address lines, a data input line, a $\overline{\text{write}}$ $\overline{\text{enable}}$ line, and three chip enables. The eight binary address inputs are decoded internally to select each of the 256 locations. An internal address register, latches and address information on the positive to negative edge of $\overline{CE}_3$. The TRI-STATE data output line working in conjunction with $\overline{CE}_1$ or $\overline{CE}_2$ inputs provides for easy memory expansion.

Address Operation: Address inputs must be stable t_{SA} prior to the positive to negative transition of $\overline{CE}_3$. It is thus not necessary to hold address information stable for more than t_{HA} after the memory is enabled (positive to negative transition).

Note: The timing is different than the DM74200 in that a positive to negative transition of the $\overline{\text{memory enable}}$ must occur for the memory to be selected.

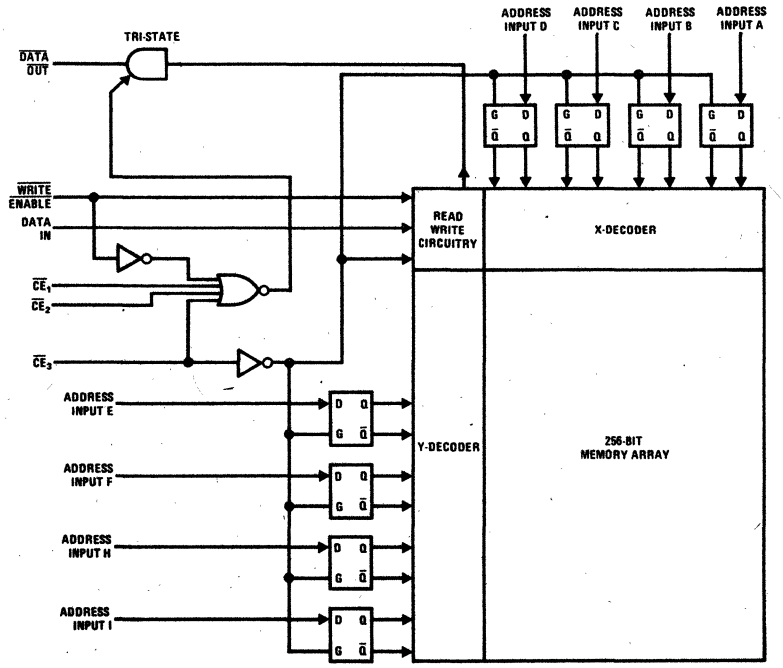
Read Operation: The data is read out by selecting the proper address and bringing $\overline{CE}_3$ low and $\overline{\text{write}}$ $\overline{\text{enable}}$ high. Holding $\overline{CE}_1$ or $\overline{CE}_2$ or $\overline{CE}_3$ at a high level forces the output into TRI-STATE. When used in bus organized systems, $\overline{CE}_1$, or $\overline{CE}_2$, a TRI-STATE control, provides for fast access times by not totally disabling the chip.

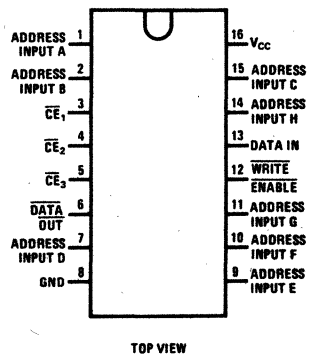
Write Operation: Data is written into the memory with $\overline{CE}_3$ low and $\overline{\text{write}}$ $\overline{\text{enable}}$ low. The state of $\overline{CE}_1$ or $\overline{CE}_2$ has no effect on the write cycle. The output assumes TRI-STATE with $\overline{\text{write}}$ $\overline{\text{enable}}$ low.

features

■ Wide supply voltage range	3.0V to 15V
■ Guaranteed noise margin	1.0V
■ High noise immunity	0.45 V_{CC} typ
■ TTL compatibility	fan out of 1 driving standard TTL
■ Low power	500 nW typ
■ Internal address register	

logic and connection diagrams





TOP VIEW

Order Number MM54C200D or MM74C200D
See Package 3
Order Number MM74C200N
See Package 15

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absolute maximum ratings (Note 1)

Voltage at Any Pin	−0.3V to V_{CC} +0.3V
Operating Temperature Range	
MM54C200	−55°C to +125°C
MM74C200	−40°C to +85°C
Storage Temperature Range	−65°C to +150°C
Package Dissipation	500 mW
Operating V_{CC} Range	3.0V to 15V
Absolute Maximum V_{CC}	16V
Lead Temperature (Soldering, 10 seconds)	300°C

dc electrical characteristics

Min/max limits apply across temperature range, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
CMOS TO CMOS					
Logical "1" Input Voltage ($V_{IN(1)}$)	V_{CC} = 5.0V	3.5			V
	V_{CC} = 10V	8.0			V
Logical "0" Input Voltage ($V_{IN(0)}$)	V_{CC} = 5.0V			1.5	V
	V_{CC} = 10V			2.0	V
Logical "1" Output Voltage ($V_{OUT(1)}$)	V_{CC} = 5.0V, I_O = −10μA	4.5			V
	V_{CC} = 10V, I_O = −10μA	9.0			V
Logical "0" Output Voltage ($V_{OUT(0)}$)	V_{CC} = 5.0V, I_O = +10μA			0.5	V
	V_{CC} = 10V, I_O = +10μA			1.0	V
Logical "1" Input Current ($I_{IN(1)}$)	V_{CC} = 15V, V_{IN} = 15V		0.005	1.0	μA
Logical "0" Input Current ($I_{IN(0)}$)	V_{CC} = 15V, V_{IN} = 0V	-1.0	-0.005		μA
Supply Current (I_{CC})	V_{CC} = 15V		0.10		μA
CMOS/LPTTL INTERFACE					
Logical "1" Input Voltage ($V_{IN(1)}$)	54C, V_{CC} = 4.5V	V_{CC} − 1.5			V
	74C, V_{CC} = 4.75V	V_{CC} − 1.5			V
Logical "0" Input Voltage ($V_{IN(0)}$)	54C, V_{CC} = 4.5V			0.8	V
	74C, V_{CC} = 4.75V			0.8	V
Logical "1" Output Voltage ($V_{OUT(1)}$)	54C, V_{CC} = 4.5V, I_O = −1.6 mA	2.4			V
	74C, V_{CC} = 4.75V, I_O = −1.6 mA	2.4			V
Logical "0" Output Voltage ($V_{OUT(0)}$)	54C, V_{CC} = 4.5V, I_O = 1.6 mA			0.4	V
	74C, V_{CC} = 4.75V, I_O = 1.6 mA			0.4	V
OUTPUT DRIVE (See 54C/74C Family Characteristics Data Sheet)					
Output Source Current (I_{SOURCE}) (P-Channel)	V_{CC} = 5.0V, V_{OUT} = 0V, T_A = 25°C	−4.0	−6.0		mA
Output Source Current (I_{SOURCE}) (P-Channel)	V_{CC} = 10V, V_{OUT} = 0V, T_A = 25°C	−16.0	−25		mA
Output Sink Current (I_{SINK}) (N-Channel)	V_{CC} = 5.0V, V_{OUT} = V_{CC}, T_A = 25°C	5.0	8.0		mA
Output Sink Current (I_{SINK}) (N-Channel)	V_{CC} = 10V, V_{OUT} = V_{CC}, T_A = 25°C	20.0	30		mA

ac electrical characteristics T_A = 25°C, C_L = 50 pF, unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Access Time From Address (t_{ACC})	V_{CC} = 5.0V		450	900	ns
	V_{CC} = 10V		200	400	ns
Propagation Delay From $\overline{CE}_3$ (t_{pd})	V_{CC} = 5.0V		360	700	ns
	V_{CC} = 10V		120	300	ns
Propagation Delay From $\overline{CE}_1$ or $\overline{CE}_2$ ($t_{p\overline{CE}1}$)	V_{CC} = 5.0V		250	500	ns
	V_{CC} = 10V		85	200	ns
Address Setup Time (t_{SA})	V_{CC} = 5.0V	200	80		ns
	V_{CC} = 10V	100	30		ns
Address Hold Time (t_{HA})	V_{CC} = 5.0V	50	15		ns
	V_{CC} = 10V	25	5		ns

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ac electrical characteristics (con't)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
$\overline{\text{Write}}$ $\overline{\text{Enable}}$ Pulse Width ($t_{\overline{WE}}$)	V_{CC} = 5.0V	300	160		ns
	V_{CC} = 10V	150	70		ns
$\overline{CE}_3$ Pulse Widths (t_{CE})	V_{CC} = 5.0V	400	200		ns
	V_{CC} = 10V	160	80		ns
Input Capacity (C_{IN})	Any Input (Note 2)		5.0		pF
Output Capacity in TRI-STATE (C_{OUT})	(Note 2)		9.0		pF
Power Dissipation Capacity (C_{pd})	(Note 3)		400		pF

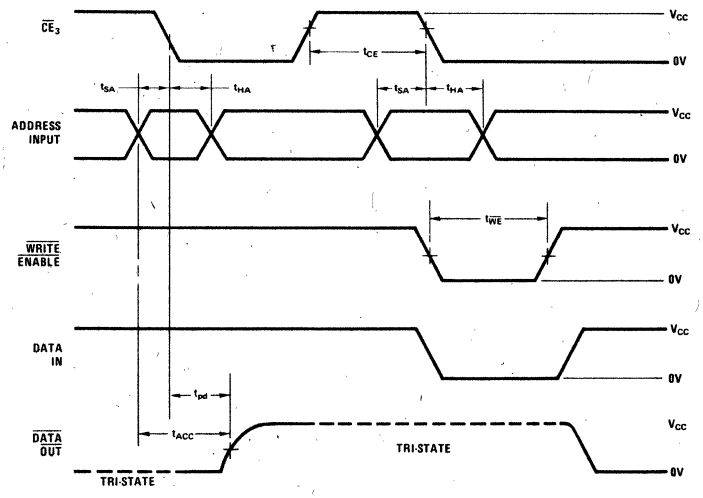
Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: Capacitance is guaranteed by periodic testing.

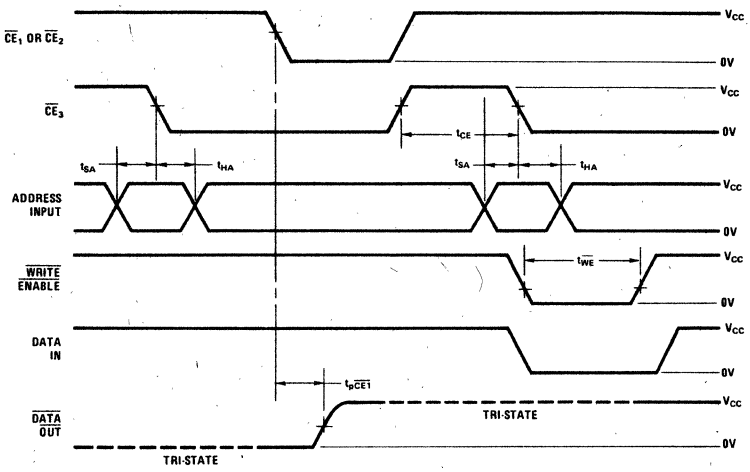
Note 3: C_{pd} determines the no load ac power consumption of any CMOS device. For complete explanation see 54C/74C Family Characteristics application note, AN-90.

switching time waveforms

Read and Write Cycles Using $\overline{CE}_3$ ($\overline{CE}_1$ = $\overline{CE}_2$ = logic 0)



Read and Write Cycles Using $\overline{CE}_3$ and $\overline{CE}_1$ (or $\overline{CE}_2$)



Note: Used for fast access time in bused systems.

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CMOS RAMs

MM54C910/MM74C910 256-bit TRI-STATE® random access read/write memory

general description

The MM54C910/MM74C910 is a 64 word by 4 bit random access memory. Inputs consist of six address lines, four data input lines, a write enable, and a memory enable line. The six address lines are internally decoded to select one of 64 word locations. An internal address register, latches the address information on the positive to negative transition of memory enable. The TRI-STATE outputs allow for easy memory expansion.

Address Operation: Address inputs must be stable (t_{SA}) prior to the positive to negative transition of memory enable, and (t_{HA}) after the positive to negative transition of memory enable. The address register holds the information and stable address inputs are not needed at any other time.

Write Operation: Data is written into memory at the selected address if write enable goes low while memory enable is low. Write enable must be held low for t_{WE} and data must remain stable t_{HD} after write enable returns high.

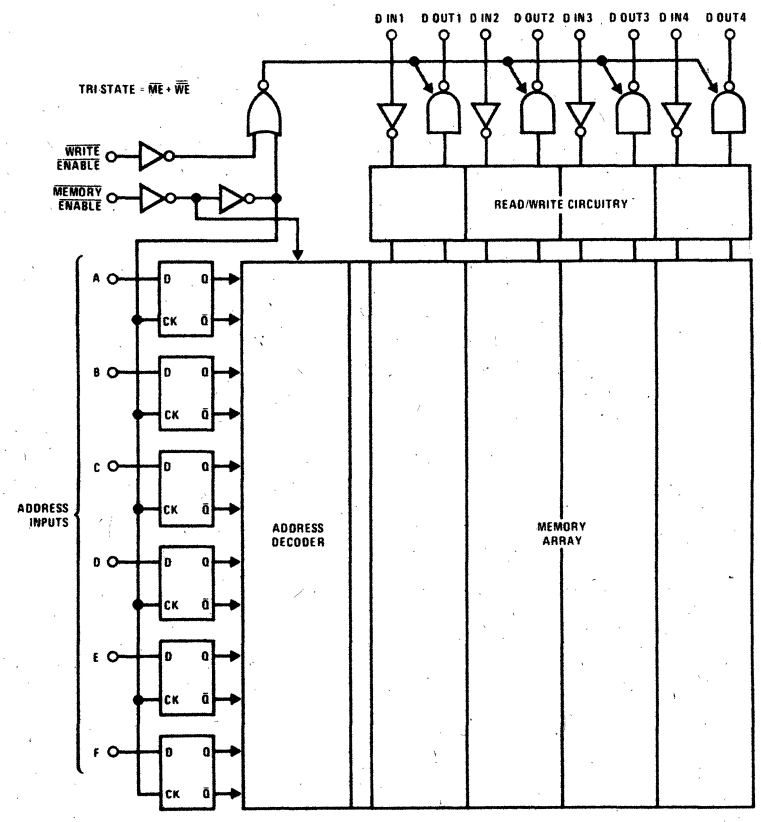
Read Operation: Data is nondestructively read from a memory location by an address operation with write enable held high.

Outputs are in the TRI-STATE (Hi-Z) condition when the device is writing or disabled.

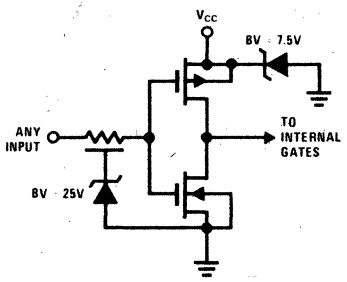
features

- Supply voltage range — 3V to 5.5V
- High noise immunity — 0.45 V_{CC} typ
- TTL compatible fan out — 1 TTL load
- Input address register
- Low power consumption — 250 nW/package typ (chip enabled or disabled)
- Fast access time — 250 ns typ at 5V
- TRI-STATE outputs
- High voltage inputs

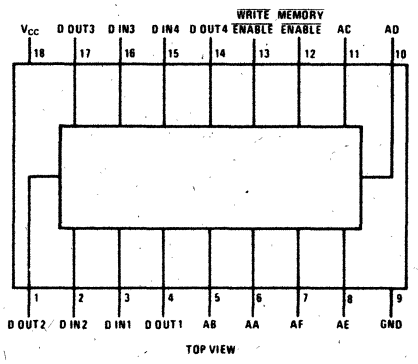
logic and connection diagrams



Input Protection



Dual-In-Line Package



Order Number MM54C910D
or MM74C910D
See Package 4

Order Number MM74C910N
See Package 16

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absolute maximum ratings (Note 1)

Voltage At Any Output Pin	−0.3V to V_{CC} +0.3V
Voltage At Any Input Pin	−0.3V to +15V
Package Dissipation	500 mW
Operating V_{CC} Range	3.0V to 5.5V
Standby V_{CC} Range	1.5V to 5.5V
Absolute Maximum V_{CC}	6.0V
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
MM54C910	4.5	5.5	V
MM74C910	4.75	5.25	V
Temperature (T_A)			
MM54C910	−55	+125	°C
MM74C910	−40	+85	°C

dc electrical characteristics MM54C910/MM74C910

(Min/max limits apply across the temperature and power supply range indicated).

	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
$V_{IN(1)}$	Logical "1" Input Voltage	Full Range	V_{CC}−1.5			V
$V_{IN(0)}$	Logical "0" Input Voltage	Full Range			0.8	V
$I_{IN(1)}$	Logical "1" Input Current	V_{IN} = 15V		0.005	2	μA
		V_{IN} = 5V		0.005	1	μA
$I_{IN(0)}$	Logical "0" Input Current	V_{IN} = 0V	−1	−0.005		μA
$V_{OUT(1)}$	Logical "1" Output Voltage	I_O = −150μA	V_{CC}−0.5			V
		I_O = −400μA	2.4			V
$V_{OUT(0)}$	Logical "0" Output Voltage	I_O = 1.6 mA			0.4	V
	Output Current in High	V_O = 5V		0.005	1	μA
	Impedence State	V_O = 0V	−1	−0.005		μA
I_{CC}	Supply Current	V_{CC} = 5V		0.05	300	μA

ac electrical characteristics MM54C910/MM74C910

T_A = 25°C, V_{CC} = 5V, C_L = 50 pF

	PARAMETER	MIN	TYP	MAX	UNITS
t_{ACC}	Access Time from Address		250	500	ns
t_{PD}	Propagation Delay from $\overline{ME}$		180	360	ns
t_{SA}	Address Input Set-Up Time	140	70		ns
t_{HA}	Address Input Hold Time	20	10		ns
t_{ME}	Memory Enable Pulse Width	200	100		ns
$t_{\overline{ME}}$	Memory Enable Pulse Width	400	200		ns
t_{SD}	Data Input Set-Up Time	0			ns
t_{HD}	Data Input Hold Time	30	15		ns
$t_{\overline{WE}}$	Write Enable Pulse Width	140	70		ns
t_{1H}, t_{OH}	Delay to TRI-STATE (Note 4)		100	200	ns
CAPACITANCE					
C_{IN}	Input Capacity				
	Any Input (Note 2)		5		pF
C_{OUT}	Output Capacity				
	Any Output (Note 2)		9		pF
C_{PD}	Power Dissipation Capacity (Note 3)		350		pF

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ac electrical characteristics (con't)

C_L = 50 pF

PARAMETER		MM54C910 T_A = −55°C to +125°C V_{CC} = 4.5V to 5.5V		MM74C910 T_A = −40°C to +85°C V_{CC} = 4.75V to 5.25V		UNITS
		MIN	MAX	MIN	MAX	
t_{ACC}	Access Time from Address		860		700	ns
t_{PD1}, t_{PD0}	Propagation Delay from $\overline{ME}$		660		540	ns
t_{SA}	Address Input Set-Up Time	200		160		ns
t_{HA}	Address Input Hold Time	20		20		ns
$t_{\overline{ME}}$	$\overline{\text{Memory Enable}}$ Pulse Width	280		260		ns
$t_{\overline{ME}}$	$\overline{\text{Memory Enable}}$ Pulse Width	750		600		ns
t_{SD}	Data Input Set-Up Time	0		0		ns
t_{HD}	Data Input Hold Time	50		50		ns
$t_{\overline{WE}}$	$\overline{\text{Write Enable}}$ Pulse Width	200		180		ns
t_{1H}, t_{0H}	Delay to TRI-STATE (Note 4)		200		200	ns

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

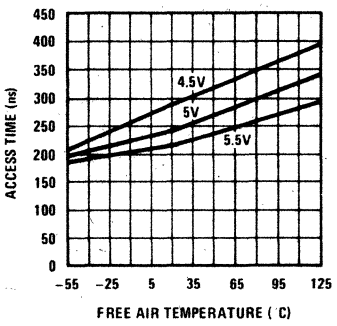
Note 2: Capacitance is guaranteed by periodic testing.

Note 3: C_{pd} determines the no load ac power consumption for any CMOS device. For complete explanation see 54C/74C Family Characteristics application note, AN-90.

Note 4: See ac test circuit for t_{1H}, t_{0H}.

typical performance characteristics

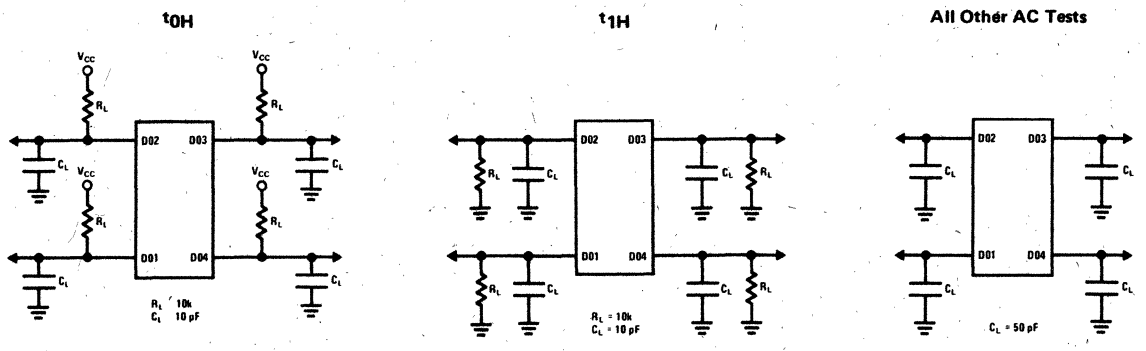
Typical Access Time vs Ambient Temperature



truth table

$\overline{ME}$	$\overline{WE}$	OPERATION	OUTPUTS
L	L	Write	TRI-STATE
L	H	Read	Data
H	L	Inhibit, Store	TRI-STATE
H	H	Inhibit, Store	TRI-STATE

ac test circuits



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MM54C920/MM74C920, MM54C921/MM74C921
1024-bit static silicon gate CMOS RAMs

general description

The MM54C920/MM74C920 256 x 4 random access read/write memory is manufactured using silicon gate CMOS technology. Data output is the same polarity as data input. Internal latches store address inputs, $\overline{CES}$ and data output. This RAM is specifically designed to operate from standard 54/74 TTL power supplies. All inputs and outputs are TTL compatible.

The MM54C921/MM74C921 is identical to the MM54C920/MM74C920, except data inputs are internally connected to data outputs; the number of package leads thereby is reduced to 18.

Complete address decoding as well as two chip select functions, $\overline{CEL}$ and $\overline{CES}$, and TRI-STATE® outputs allow easy expansion with a minimum of external components. Versatility plus high speed and low power make these RAMs ideal elements for use in microprocessor, minicomputer as well as main frame memory applications.

features

- Fast access—250 ns max
- TRI-STATE outputs
- Low power
- On-chip registers
- Single +5V supply
- Data retained with V_{CC} as low as 2V

functional description

The functional description will reference the logic diagram of the MM54C920/MM74C920 shown in *Figure 1.* Input addresses and $\overline{CES}$ are clocked into the input latches by the falling edge of $\overline{STROBE}$. Input setup and hold times must be observed on these signals (see timing diagrams). The true and complement address information is fed to the row and column decoders which access the selected 4-bit memory word.

logic and connection diagrams

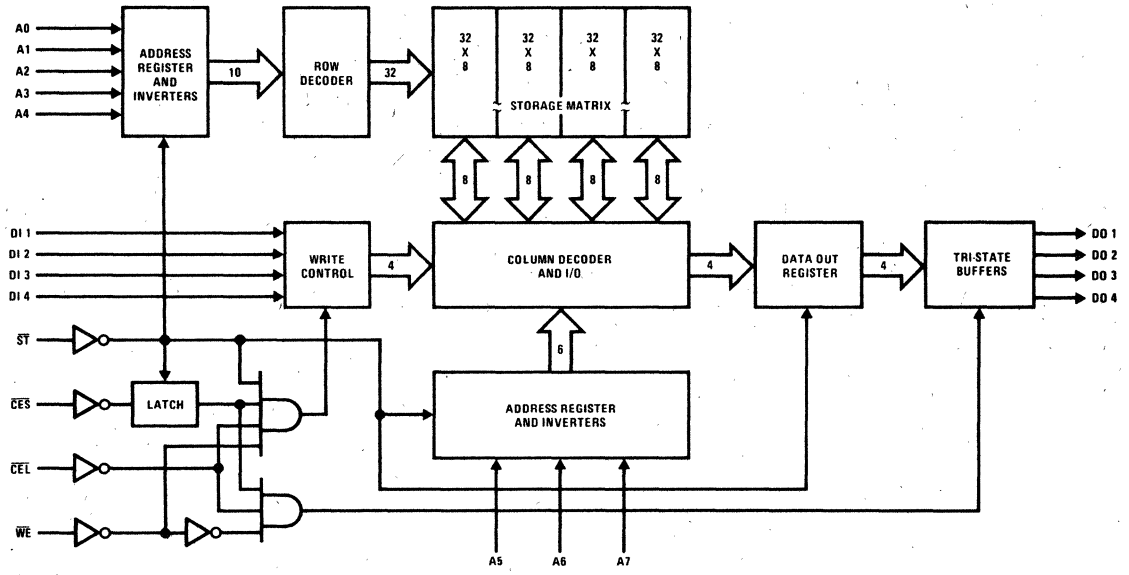
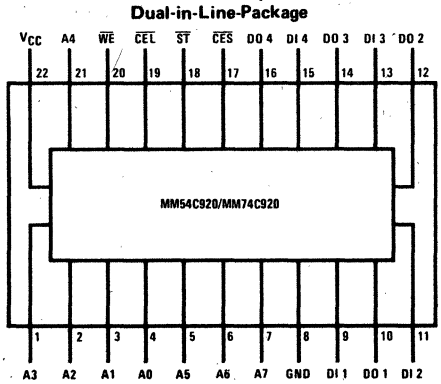
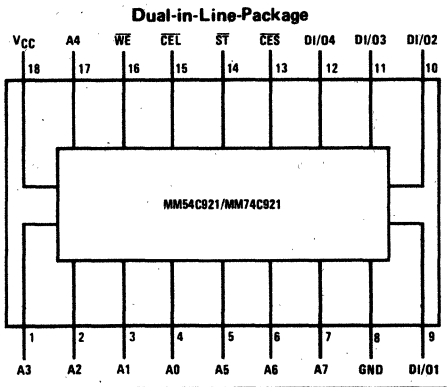


FIGURE 1. MM54C920/MM74C920 Logic Diagram

Dual-in-Line-Package



Dual-in-Line-Package



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functional description (con't)

The addressed word (4 bits) is fed to four sense amplifiers through the column decoders. The information from the sense amplifiers is retained in the output register when $\overline{STROBE}$ rises. The register drives the TRI-STATE output buffers.

Chip select inputs, $\overline{CEL}$ and $\overline{CES}$, have identical functions except that $\overline{CES}$ (Chip Enable Stored) is clocked into a latch on the falling edge of $\overline{STROBE}$; $\overline{CEL}$ (Chip Enable Level) is not.

Note that setup and hold times must be observed on $\overline{CES}$. Because $\overline{CEL}$ is not clocked by $\overline{STROBE}$, it may fall after $\overline{STROBE}$ has fallen without affecting access time.

The outputs are in a high impedance state when the chip is not selected ($\overline{CES}$ or $\overline{CEL}$ high) or when writing ($\overline{WE}$ low). Note that the information stored in the output latches will be changed whenever $\overline{STROBE}$ falls, regardless of the logic states of $\overline{WE}$, $\overline{CEL}$ or $\overline{CES}$.

The timing diagrams in *Figures 2, 3, and 4* define the read, write, and output enable/disable parameters respectively.

absolute maximum ratings

Supply Voltage, V_{CC}	7V
Voltage at Any Pin	−0.3V to V_{CC} + 0.3V
Operating Temperature Range	
MM54C920, MM54C921	−55°C to +125°C
MM74C920, MM74C921	−40°C to +85°C
Storage Temperature Range	−65°C to +150°C

dc electrical characteristics V_{CC} = 5.0V ±10%, T_A = Operating Range

PARAMETER		CONDITIONS	MM54C920, MM54C921			MM74C920, MM74C921			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IH}	Logical "1" Input Voltage		V_{CC}−2.0		V_{CC}	V_{CC}−2.0		V_{CC}	V
V_{IL}	Logical "0" Input Voltage		0		0.8	0		0.8	V
V_{OH1}	Logical "1" Output Voltage	I_{OH} = −1.0 mA	2.4			2.4			V
V_{OH2}	Logical "1" Output Voltage	I_{OUT} = 0	V_{CC}−0.01			V_{CC}−0.01			V
V_{OL1}	Logical "0" Output Voltage	I_{OL} = 2.0 mA			0.4			0.4	V
V_{OL2}	Logical "0" Output Voltage	I_{OUT} = 0			0.01			0.01	V
I_{IL}	Input Leakage	$0V \le V_{IN} \le V_{CC}$	−1.0	0.001	1.0	−1.0	0.001	1.0	μA
I_Q	Output Leakage	$0V \le V_O \le V_{CC}$, $\overline{CEL}$ = V_{CC}	−1.0	0.001	1.0	−1.0	0.001	1.0	μA
I_{CC}	Supply Current	V_{IN} = V_{CC}, V_O = 0V		0.1	10		0.1	10	μA
C_{IN}	Input Capacitance	(Note 1)		4	7		4	7	pF
C_O	Output Capacitance	(Note 1)		6	9		6	9	pF
$C_{I/O}$	Data Input/Output Capacitance	MM54C921/MM74C921 Only		8	12		8	12	pF
V_{DR}	V_{CC} for Data Retention	$\overline{CEL}$ = V_{CC}	2.0			2.0			V

Note 1: Capacitance is guaranteed by periodic testing.

ac electrical characteristics V_{CC} = 5.0V ±10%, T_A = Operating Range

PARAMETER		MM54C920, MM54C921			MM74C920, MM74C921			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
TTL Interface (V_{IH} = V_{CC} − 2.0V, V_{IL} = 0.8V, Input t_{RISE} = t_{FALL} = 5 ns, Load = 1 TTL Gate + 50 pF)								
t_C	Cycle Time	290	120		255	120		ns
t_{ACC}	Access Time From Address		120	275		120	250	ns
t_{ACS}	Access Time From Strobe		110	250		110	225	ns
t_{AS}	Address Setup Time	25	10		25	10		ns
t_{AH}	Address Hold Time	25	15		25	15		ns
t_{OE}	Output Enable Time		60	150		60	130	ns
t_{OD}	Output Disable Time		60	150		60	130	ns
$t_{\overline{ST}}$	$\overline{ST}$ Pulse Width (Negative)	150	60		130	60		ns
t_{ST}	ST Pulse Width (Positive)	140	60		125	60		ns
t_{WP}	Write Pulse Width (Negative)	150	80		130	80		ns
t_{DS}	Data Setup Time	100	40		90	40		ns
t_{DH}	Data Hold Time	60	25		60	25		ns

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MM54C929/MM74C929, MM54C930/MM74C930
1024-bit static silicon gate CMOS RAMs

general description

The MM54C929/MM74C929 and the MM54C930/MM74C930 1024 x 1 random access read/write memories are manufactured using silicon gate CMOS technology. These RAMS are specifically designed to operate from standard 54/74 TTL power supplies; all inputs and outputs are TTL compatible. Data output is the same polarity as data input. Internal latches store the address inputs and data output. Chip select input $\overline{CS1}$ serves as a chip strobe, controlling address and data latching. The Data-In and Data-Out terminals can be tied together for common I/O applications. Complete address decoding, three chip select functions (MM54C930/MM74C930) and TRI-STATE® output allow easy memory expansion and organization. The MM54C929/MM74C929 differs from the MM54C930/MM74C930 only in that $\overline{CS1}$, $\overline{CS2}$ and $\overline{CS3}$ are internally connected together, providing a single chip-select input. Versatility, high speed, and low power make these RAMs ideal elements for use in many microprocessor minicomputer and main frame memory applications.

features

- Fast access—250 ns max
- TRI-STATE outputs
- Low power—10μA max standby
- On-chip registers
- Single 5V supply
- Inputs and output TTL compatible
- Data retained with V_{CC} as low as 2V
- Can be operated common I/O

block and connection diagrams

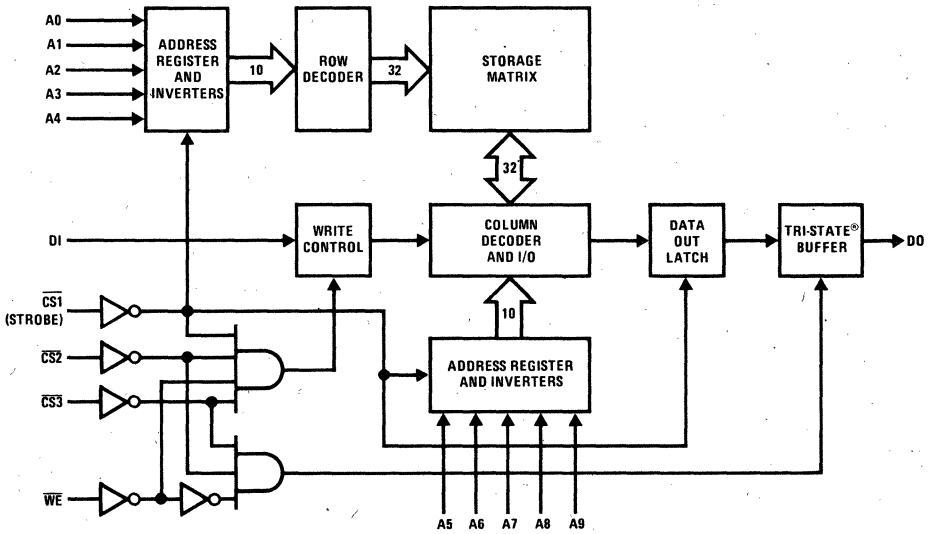
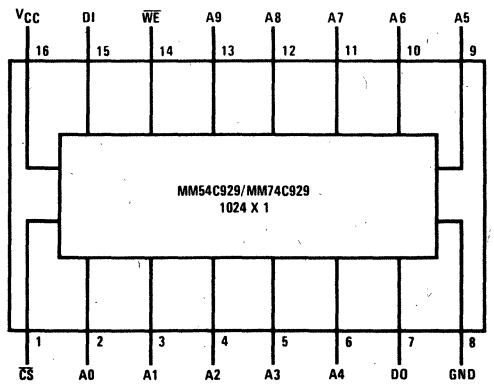
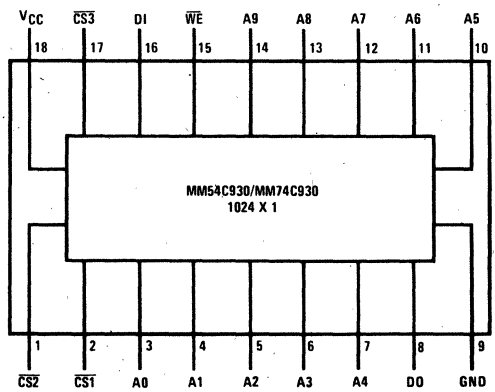


FIGURE 1. Block Diagram

Dual-In-Line Package



Dual-In-Line Package



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absolute maximum ratings

Supply Voltage, V_{CC}	7V
Voltage at Any Pin	−0.3V to V_{CC} + 0.3V
Operating Temperature Range	
MM54C929, MM54C930	−55°C to +125°C
MM74C929, MM74C930	−40°C to +85°C
Storage Temperature Range	−65°C to +150°C

dc electrical characteristics V_{CC} = 5V ±10%, T_A = Operating Range

PARAMETER		CONDITIONS	MM54C929, MM54C930			MM74C929, MM74C930			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IH}	Logical "1" Input Voltage		V_{CC}−2.0		V_{CC}	V_{CC}−2.0		V_{CC}	V
V_{IL}	Logical "0" Input Voltage		0		0.8	0		0.8	V
V_{OH1}	Logical "1" Output Voltage	I_{OH} = −1 mA	2.4			2.4			V
V_{OH2}	Logical "1" Output Voltage	I_{OUT} = 0	V_{CC}−0.01			V_{CC}−0.01			V
V_{OL1}	Logical "0" Output Voltage	I_{OL} = 2 mA			0.4			0.4	V
V_{OL2}	Logical "0" Output Voltage	I_{OUT} = 0			0.01			0.01	V
I_{IL}	Input Leakage	$0V \le V_{IN} \le V_{CC}$	−1.0	0.001	1.0	−1.0	0.001	1.0	μA
I_O	Output Leakage	$0V \le V_O \le V_{CC}$, $\overline{CS2}$ or $\overline{CS3}$ = V_{CC}	−1.0	0.001	1.0	−1.0	0.001	1.0	μA
I_{CC}	Supply Current	$V_{IN} = V_{CC}$, V_O = 0V		0.1	10		0.1	10	μA
C_{IN}	Input Capacitance	(Note 1)		5			5		pF
C_O	Output Capacitance	(Note 1)		5			5		pF
V_{DR}	V_{CC} for Data Retention	$\overline{CS2}$ or $\overline{CS3}$ = V_{CC}	2.0			2.0			V

Note 1: Capacitance maximum is guaranteed by periodic testing.

ac electrical characteristics V_{CC} = 5V ±10%, T_A = Operating Range

PARAMETER		MM54C929, MM54C930			MM74C929, MM74C930			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
TTL Interface (V_{IH} = V_{CC} − 2V, V_{IL} = 0.8V, Input t_{RISE} = t_{FALL} = 5 ns, Load = 1 TTL Gate + 50 pF)								
t_C	Cycle Time		140			140		ns
t_{ACC}	Access Time From Address		100			100		ns
t_{ACS1}	Access Time From $\overline{CS1}$		100			100		ns
t_{AS}	Address Setup Time		0			0		ns
t_{AH}	Address Hold Time		15			15		ns
t_{OE}	Output Enable Time		60			60		ns
t_{OD}	Output Disable Time		60			60		ns
$t_{\overline{CS1}}$	$\overline{CS1}$ Pulse Width (Negative)		60			60		ns
t_{CS1}	$\overline{CS1}$ Pulse Width (Positive)		60			60		ns
t_{WP}	Write Pulse Width (Negative)		80			80		ns
t_{DS}	Data Setup Time		100			100		ns
t_{DH}	Data Hold Time		0			0		ns

truth tables

MM54C929/MM74C929

$\overline{CS}$	$\overline{WE}$	DI	FUNCTION
1	X	X	Output in Hi-Z State
X	0	X	Output in Hi-Z State
0	0	0	Write "0," Output in Hi-Z State
0	0	1	Write "1," Output in Hi-Z State
0	1	X	Read Data, Output Enabled

X = Don't care

MM54C930/MM74C930

$\overline{CS1}$	$\overline{CS2}$	$\overline{CS3}$	$\overline{WE}$	DI	FUNCTION
X	1	X	X	X	Output in Hi-Z State
X	X	1	X	X	Output in Hi-Z State
X	X	X	0	X	Output in Hi-Z State
0	0	0	0	0	Write "0," Output in Hi-Z State
0	0	0	0	1	Write "1," Output in Hi-Z State
0	0	0	1	X	Read Data, Output Enabled

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MOS EPROMs

MM1702A 2048-bit electrically programmable ROM

general description

The MM1702A is a 256 word by 8-bit electrically programmable ROM ideally suited for uses where fast turn-around and pattern experimentation are important. The MM1702A undergoes complete programming and functional testing on each bit position prior to shipment, thus insuring 100% programmability.

The MM1702AQ is packaged in a 24-pin dual-in-line package with a transparent lid. The transparent lid allows the user to expose the chip to ultraviolet light to erase the bit pattern. A new pattern can then be written into the device. The MM1702AD is packaged in a 24-pin dual-in-line package with a metal lid and is not erasable.

The circuitry of the MM1702A is entirely static; no clocks are required.

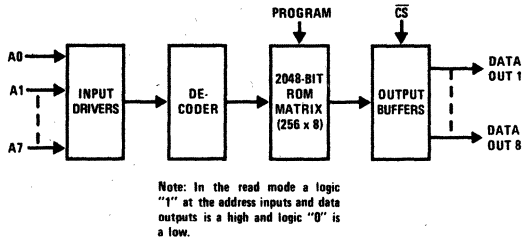
A pin-for-pin metal mask programmed ROM, the MM1302 is ideal for large volume production runs of systems initially using the MM1702A.

The MM1702A is fabricated with silicon gate technology. This low threshold technology allows the design and production of higher performance MOS circuits and provides a higher functional density on a monolithic chip than conventional MOS technologies.

features

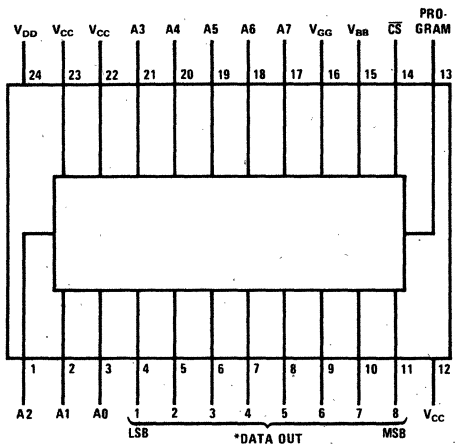
- Fast programming—30 seconds for all 2048 bits
- All 2048 bits guaranteed programmable—100% factory tested
- Fully decoded, 256 x 8 organization
- Static MOS—no clocks required
- Inputs and outputs DTL and TTL compatible
- TRI-STATE® output—OR-tie capability
- Simple memory expansion—chip select input lead
- Direct replacement for the Intel 1702A

block and connection diagrams



Note: In the read mode a logic "1" at the address inputs and data outputs is a high and logic "0" is a low.

Dual-In-Line Package



*This pin is the data input lead during programming.

Order Number MM1702AD
See Package 6

Order Number MM1702AQ
See Package 21

Pin Names

A0—A7	Address Inputs
$\overline{CS}$	Chip Select Input
$D_{OUT\ 1} - D_{OUT\ 8}$	Data Outputs

Pin Connections*

MODE/PIN	12 (V_{CC})	13 (PROGRAM)	14 ($\overline{CS}$)	15 (V_{BB})	16 (V_{GG})	22 (V_{CC})	23 (V_{CC})
Read	V_{CC}	V_{CC}	GND	V_{CC}	V_{GG}	V_{CC}	V_{CC}
Programming	GND	Program Pulse	GND	V_{BB}	Pulsed V_{GG} (V_{IL4P})	GND	GND

*The external lead connections to the MM1702A differ, depending on whether the device is being programmed or used in read mode. (See following table.) In the programming mode, the data inputs 1—8 are pins 4—11 respectively.

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absolute maximum ratings (Note 1)

Ambient Temperature	0°C to +70°C
Storage Temperature	−65°C to +125°C
Power Dissipation	2W
Read Operation	
Input Voltages and Supply Voltages with Respect to V_{CC}	+0.5V to −20V
Program Operation	
Input Voltages and Supply Voltages with Respect to V_{CC}	−48V
Lead Temperature (Soldering, 10 seconds)	300°C

read operation dc characteristics

T_A = 0°C to +70°C, V_{CC} = +5V ±5%, V_{DD} = −9V ±5%, V_{GG} = −9V ±5%, unless otherwise noted. Typical values are at nominal voltages and T_A = 25°C. (Note 2)

	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
I_{LI}	Address and Chip Select Input Load Current	V_{IN} = 0.0V			1	μA
I_{LO}	Output Leakage Current	V_{OUT} = 0.0V, $\overline{CS}$ = V_{CC} −2			1	μA
I_{DDO}	Power Supply Current	V_{GG} = V_{CC}, $\overline{CS}$ = V_{CC} −2 I_{OL} = 0.0 mA, T_A = 25°C, (Note 2)		5	10	mA
I_{DD1}	Power Supply Current	$\overline{CS}$ = V_{CC} −2, I_{OL} = 0.0 mA, T_A = 25°C		35	50	mA
I_{DD2}	Power Supply Current	$\overline{CS}$ = 0.0, I_{OL} = 0.0 mA, T_A = 25°C		32	46	mA
I_{DD3}	Power Supply Current	$\overline{CS}$ = V_{CC} −2, I_{OL} = 0.0 mA, T_A = 0°C		38.5	60	mA
I_{CF1}	Output Clamp Current	V_{OUT} = −1.0V, T_A = 0°C		8	14	mA
I_{CF2}	Output Clamp Current	V_{OUT} = −1.0, T_A = 25°C			13	mA
I_{GG}	Gate Supply Current				1	μA
V_{IL1}	Input Low Voltage for TTL Interface		−1.0		V_{CC}−4.1	V
V_{IL2}	Input Low Voltage for MOS Interface		V_{DD}		V_{CC}−6	V
V_{IH}	Address and Chip Select Input High Voltage		V_{CC}−2		V_{CC}+0.3	V
I_{OL}	Output Sink Current	V_{OUT} = 0.45V	1.6	4		mA
I_{OH}	Output Source Current	V_{OUT} = 0.0V	−2.0			mA
V_{OL}	Output Low Voltage	I_{OL} = 1.6 mA		−0.7	0.45	V
V_{OH}	Output High Voltage	I_{OH} = −100μA	3.5	4.5		V

Note 1: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and and functional operation of the device at these or at any other condition above those indicated in the operational sections of this specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

Note 2: Power-Down Option: V_{GG} may be clocked to reduce power dissipation. The average I_{DD} will vary between I_{DD0} and I_{DD1} depending on the V_{GG} duty cycle (see typical characteristics). For this option, please specify MM1702AL.

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read operation ac characteristics

$T_A = 0°C$ to $+70°C$, $V_{CC} = +5V \pm 5\%$, $V_{DD} = -9V \pm 5\%$, $V_{GG} = -9V \pm 5\%$, unless otherwise noted.

PARAMETER		MIN	TYP	MAX	UNITS
Freq.	Repetition Rate			1	MHz
t_{OH}	Previous Read Data Valid			100	ns
t_{ACC}	Address to Output Delay		0.7	1	μs
t_{DVGG}	Clocked V_{GG} Set-Up (Note 1)	1			μs
t_{CS}	Chip Select Delay			100	ns
t_{CO}	Output Delay From $\overline{CS}$			900	ns
t_{OD}	Output Deselect			300	ns
t_{OHC}	Data Out Hold in Clocked V_{GG} Mode (Note 1)			5	μs

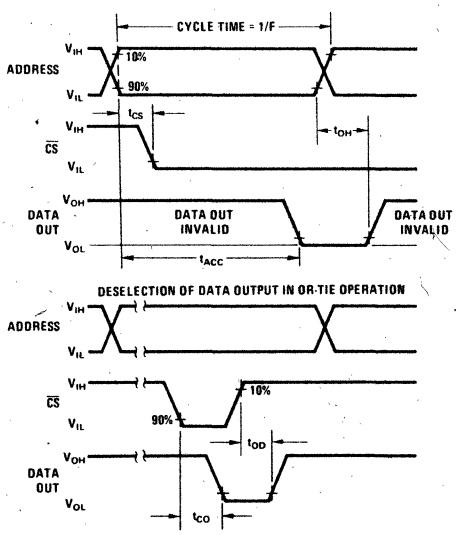
capacitance characteristics $T_A = 25°C$ (Note 3)

PARAMETER		CONDITIONS		MIN	TYP	MAX	UNITS
C_{IN}	Input Capacitance	All Unused	$V_{IN} = V_{CC}$		8	15	pF
C_{OUT}	Output Capacitance	Pins Are	$\overline{CS} = V_{CC}$		10	15	pF
C_{VGG}	V_{GG} Capacitance (Note 1)	At ac Ground	$V_{OUT} = V_{CC}$ $V_{GG} = V_{CC}$			30	pF

Note 3: This parameter is periodically sampled and is not 100% tested.

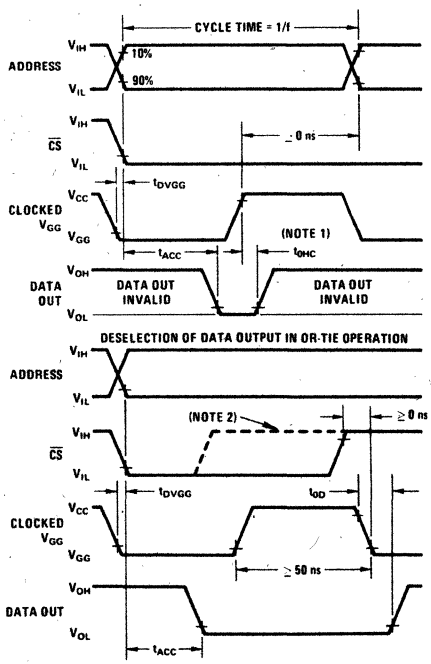
read operation switching time waveforms

(a) Constant V_{GG} Operation



Conditions of Test:
Input pulse amplitudes: 0–4V, t_r, $t_f \leq 50$ ns. Output load is 1 TTL gate; measurements made at output of TTL gate ($t_{PD} \leq 15$ ns), $C_L = 15$ pF.

(b) Power-Down Option (Note 1)



Note 1: The output will remain valid for t_{OHC} as long as clocked V_{GG} is at V_{CC}. An address change may occur as soon as the output is sensed (clocked V_{GG} may still be at V_{CC}). Data becomes invalid for the old address when clocked V_{GG} is returned to V_{GG}.

Note 2: If $\overline{CS}$ makes a transition from V_{IL} to V_{IH} while clocked V_{GG} is at V_{GG}, then deselection of output occurs at t_{OD} as shown in static operation with constant V_{GG}.

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programming operation dc characteristics

$T_A = 25°C$, $V_{CC} = 0V$, $V_{BB} = 12V \pm 10\%$, $\overline{CS} = 0V$ unless otherwise noted.

	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
I_{LI1P}	Address and Data Input Load Current	$V_{IN} = -48V$			10	mA
I_{LI2P}	Program and V_{GG} Load Current	$V_{IN} = -48V$			10	mA
I_{BB}	V_{BB} Supply Load Current	(Note 5)		10	100	mA
I_{DDP}	Peak I_{DD} Supply Load Current	$V_{DD} = V_{PROG} = -48V$ $V_{GG} = -35V$ (Note 4)		200	300	mA
V_{IHP}	Input High Voltage				0.3	V
V_{IL1P}	Pulsed Data Input Low Voltage		−46		−48	V
V_{IL2P}	Address Input Low Voltage		−40		−48	V
V_{IL3P}	Pulsed Input Low V_{DD} and Program Voltage		−46		−48	V
V_{IL4P}	Pulsed Input Low V_{GG} Voltage		−35		−40	V

Note 4: I_{DDP} flows only during V_{DD}, V_{GG} on time. I_{DDP} should not be allowed to exceed 300 mA for greater than 100μs. Average power supply current I_{DDP} is typically 40 mA at 20% duty cycle.

Note 5: The V_{BB} supply must be limited to 100 mA max current to prevent damage to the device.

programming operation ac characteristics

$T_A = 25°C$, $V_{CC} = 0V$, $V_{BB} = 12V \pm 10\%$, $\overline{CS} = 0V$ unless otherwise noted.

	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
	Duty Cycle (V_{DD}, V_{GG})				20	%
$t_{\phi PW}$	Program Pulse Width	$V_{GG} = -35V$, $V_{DD} = V_{PROG} = -48V$			3	ms
t_{DW}	Data Set-Up Time		25			μs
t_{DH}	Data Hold Time		10			μs
t_{VW}	V_{DD}, V_{GG} Set-Up		100			μs
t_{VD}	V_{DD}, V_{GG} Hold		10		100	μs
t_{ACW}	Address Complement Set-Up	(Note 6)	25			μs
t_{ACH}	Address Complement Hold	(Note 6)	25			μs
t_{ATW}	Address True Set-Up		10			μs
t_{ATH}	Address True Hold		10			μs

Note 6: All 8 address bits must be in the complement state when pulsed V_{DD} and V_{GG} move to their negative levels. The addresses (0–255) must be programmed as shown in the timing diagram until data reads true, then over-programmed 4 times that amount. (Symbolized by x + 4x.)

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MOS EPROMs

MM4203/MM5203 electrically programmable 2048-bit read only memory (pROM)

general description

The MM4203/MM5203 is a 2048-bit static read-only memory which is electrically programmable and uses silicon gate technology to achieve bipolar compatibility. The device is a non-volatile memory organized as a 256-8-bit words or 512-4-bit words. Programming of the memory contents is accomplished by storing a charge in a cell location by programming that location with a 50 volt pulse. Separate output supply lead is provided to reduce internal power dissipation in the output stage (V_{LL}).

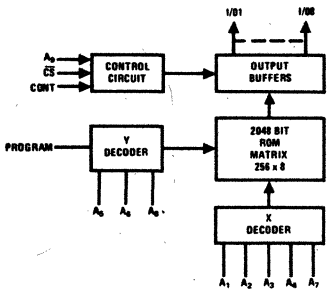
features

- Field programmable
- Bipolar compatibility — +5V, −12V operation
- High speed operation — 1μs max access time
- Pin compatible with MM5213, MM5231 mask programmable ROMs
- Static operation — no clocks required
- Common data busing (TRI-STATE® output)
- "Q" quartz lid version erasable with short wave ultra-violet light (i.e. 253.7 n.m.)
- Chip select output control
- 256 x 8 or 512 x 4 organization

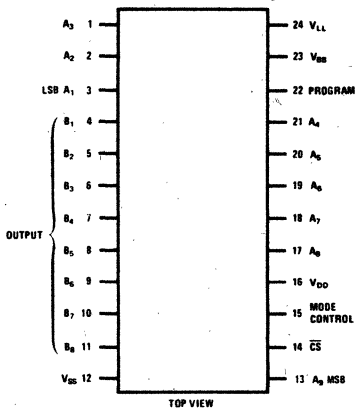
applications

- Code conversion
- Random logic synthesis
- Table look-up
- Character generator
- Micro-programming

block and connection diagrams



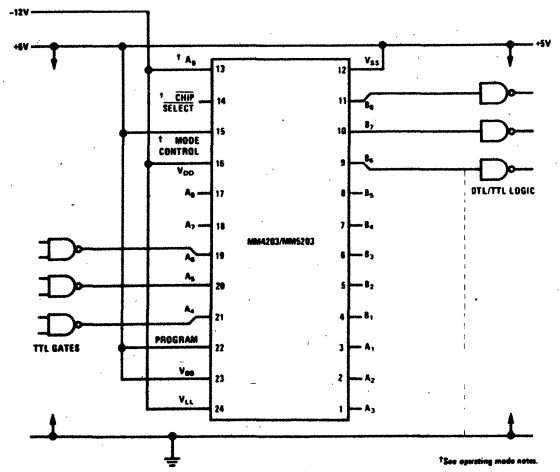
Dual-In-Line Package



Order Number MM4203D or MM5203D
See Package 6
Order Number MM4203Q or MM5203Q
See Package 21

typical applications

256 x 8 PROM Showing TTL Interface



Operating Modes

256 x 8 ROM connection (shown)
Mode Control — HIGH (V_{SS})
A_9 — LOW

512 x 4 ROM connections
Mode Control — LOW (GND or V_{DD})
A_9 — Logic HIGH enables the odd (B_1, B_3..B_7) outputs
— Logic LOW enables the even (B_2, B_4..B_8) outputs

The outputs are enabled when a logic LOW is applied to the Chip Select line.

Programming is accomplished in 256 x 8 mode only.

Note: For programming information see AN-100.

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absolute maximum ratings

All Input or Output Voltages with Respect to V_{BB} Except During Programming: +.3V to −20V
Power Dissipation: 1W
Operating Temperature Range MM4203: −55°C to 85°C
MM5203: 0°C to 70°C
Storage Temperature Range: −65°C to 125°C
Lead Temperature (Soldering, 10 sec): 300°C

electrical characteristics

T_A within operating temperature range, V_{SS} = +5V ±5%, $V_{DD} = V_{LL}$ = −12V, ±5%, V_{BB} = PROGRAM = V_{SS} unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Current, I_{LI}	V_{IN} = 0V			1	μA
Output Leakage, I_{LO}	V_{OUT} = 0V $\overline{CS} = V_{SS}$ - 2.0			1	μA
Power Supply Current, I_{SS}	T_A = 25°C $\overline{CS} = V_{SS}$ - 2.0		35	55	mA
Input LOW Voltage, V_{IL}		V_{SS} - 10		V_{SS} - 4.0	V
Input HIGH Voltage, V_{IH}		V_{SS} - 2.0		V_{SS} + .3	V
Output LOW Voltage, V_{OL}	1.6 mA sink $-12.6V < V_{LL} < -3V$			.40	V
Output Clamp Current, I_{CF}	V_{LL} = -3.0V V_{OUT} = -1.0V (Note 8) T_A = 0°C		3.5	6.0	mA
	V_{LL} = -12.6V V_{OUT} = -1.0V (Note 8) T_A = 0°C		8.0	15.0	mA
Output HIGH Voltage, V_{OH}	0.8 mA source	2.4			V
Data Hold Time, T_{OH}	(Min Access Time)			100	ns
Access Time, T_{ACC}	T_A = 25°C (Note 6)		.700	1	μs
Chip Select Time, T_{CO}				500	ns
Chip Deselect Time, T_{OD}				500	ns
Allowable Chip Select Delay, t_{CS}	Allowable delay in selecting chip after change of address without affecting access time.			100	ns
Input Capacitance, C_{IN}	$V_{IN} = V_{SS}$ } f = 1.0 MHz (Note 2)		8	15	pF
Output Capacitance, C_{OUT}	$V_{OUT} = V_{SS}$ } $\overline{CS} = V_{SS}$ - 2.0		8	15	pF

programming characteristics

T_A = 25°C, V_{SS} = 0V, V_{BB} = +12V ±10%, $\overline{CS}$ = 0V unless otherwise noted

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Address and Data Input Load Current, I_{LD}	V_{IN} = −50V		0	10	mA
Program Load Current, I_{LP}	V_{IN} = −50V		0	10	mA
V_{BB} Supply Load Current, I_{LB}			0	10	mA
Peak I_{DD} Supply Load Current I_{LDD} (Note 3)	$V_{DD} = V_{program}$ = −50V		650		mA
Input High Voltage, V_{IHP}		−2		+.3	V
Address and Data Input Low Voltage, V_{ILP}		−50		−40	V
Pulsed Input Low Voltage:					
V_{DD}, and Program, V_{DLP}		−50		−48	V
V_{LL}	(Note 5)	−50		0	V
V_{DD} Pulse Duty Cycle				2	%
Program Pulse Width, t_{PW} (Note 4)	$V_{DD} = V_{program}$ = −50V			20	ms
Data and Address Set Up Time, t_{DW}		1			μs
Data and Address Hold Time, t_{DH}		0			μs
Pulsed V_{DD} Supply Overlap, t_{SS}		1		100	μs
Pulsed V_{DD} Supply Overlap, t_{SH}		−.1		3	ms
V_{DD}, Program, Address, and Input Rise and Fall Times				1	μs

Note 1: During programming, data is always applied in the 256 x 8 mode, regardless of the logic state of Ag and MODE CONTROL.
Note 2: Capacitances are not tested on a production basis but are periodically sampled.
Note 3: I_{DDP} flows only during program period t_{PWP}. Average power supply current I_{LDD} is typically 15 mA at 2% duty cycle.
Note 4: Maximum duty cycle of t_{PW} should not be greater than 2% of cycle time so that power dissipation is minimized. The program cycle should be repeated until the data reads true, then over-program three times that number of cycles (symbolized as X+3X programming.
Note 5: V_{LL} is not needed during programming but may be tied to V_{DD} for convenience.
Note 6: T_{ACC} = 1000 ns + 25(N-1) where N is the number of chips wired-OR together.
Note 7: Measured under continuous operation.
Note 8: I_{CF} flows out the V_{LL} pin, it does not flow out the V_{DD} pin.

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MOS EPROMs

MM4204/MM5204
electrically programmable 4096-bit read only memory (EROM)

general description

The MM4204/MM5204 is a 4096-bit static Read Only Memory which is electrically programmable and uses silicon gate technology to achieve bipolar compatiblity. The device is a non-volatile memory organized as 512 words by 8 bits per word. Programming of the memory is accomplished by storing a charge in a cell location by applying a −50V pulse. A logic input, "Power Saver," is provided which gives a 5:1 decrease in power when the memory is not being accessed.

- Standard power supplies 5.0V, −12V
- Static operation—no clock required
- Easy memory expansion—TRI-STATE® output Chip Select input ($\overline{CS}$)
- "Q" quartz lid version erasable with short wave ultraviolet light (i.e., 253.7 nm)
- Low power dissipation
- "Power Saver" control for low power applications

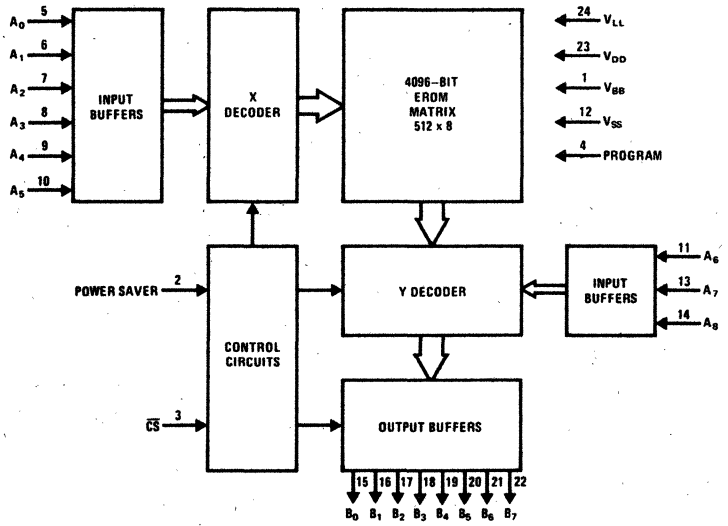
features

- Field programmable
- Fast program time: ten seconds typical for 4096-bits
- Fast access time
  - MM4204 1.25μs
  - MM5204 1μs
- DTL/TTL compatibility

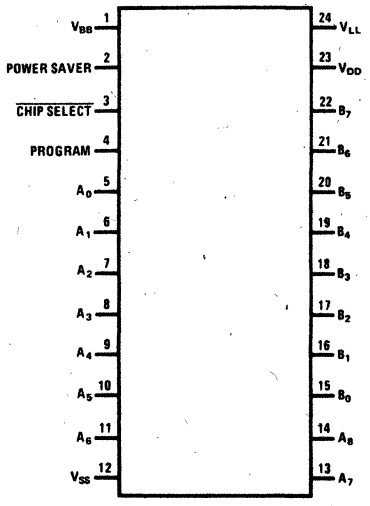
applications

- Code conversion
- Random logic synthesis
- Table look-up
- Character generator
- Microprogramming
- Electronic keyboards

block and connection diagrams



Dual-In-Line Package



TOP VIEW

Order Number MM4204D or MM5204D
See Package 6

Order Number MM4204Q or MM5204Q
See Package 21

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absolute maximum ratings (Note 1)

All Input or Output Voltages with Respect to V_{BB} Except During Programming	+0.3V to −20V
Power Dissipation	750 mW
Operating Temperature Range	
MM5204	0°C to +70°C
MM4204	−55°C to +85°C
Storage Temperature Range	−65°C to +125°C
Lead Temperature (Soldering, 10 seconds)	300°C

dc electrical characteristics

T_A within operating temperature range, V_{LL} = 0V, V_{BB} = PROGRAM = V_{SS}, MM4204: V_{SS} = 5.0V ±10%, V_{DD} = −12V ±10%, MM5204: V_{SS} = 5.0V ±5%, V_{DD} = −12V ±5%, unless otherwise noted.

PARAMETER		CONDITIONS	MIN	TYP (Note 7)	MAX	UNITS
V_{IL}	Input Low Voltage		V_{SS}−14		V_{SS}−4.2	V
V_{IH}	Input High Voltage		V_{SS}−1.5		V_{SS}+0.3	V
I_{LI}	Input Current	V_{IN} = 0V			1.0	μA
V_{OL}	Output Low Voltage	I_{OL} = 1.6 mA	V_{LL}		0.4	V
V_{OH}	Output High Voltage	I_{OH} = −0.8 mA	2.4		V_{SS}	V
I_{LO}	Output Leakage Current	V_{OUT} = 0V, $\overline{CS}$ = V_{IH}			1.0	μA
I_{DD}	Power Supply Current	MM5204 T_A = 0°C, $\overline{CS}$ = V_{IH}, Power Saver = V_{IL}		28	40.0	mA
		MM4204 T_A = 0°C, $\overline{CS}$ = V_{IH}, Power Saver = V_{IL}			50.0	mA
		MM5204 T_A = 0°C, $\overline{CS}$ = V_{IH}, Power Saver = V_{IH}		6.0	8.0	mA
		MM4204 T_A = 0°C, $\overline{CS}$ = V_{IH}, Power Saver = V_{IH}			10.0	mA
I_{SS}		MM5204 T_A = 0°C, $\overline{CS}$ = V_{IH}, Power Saver = V_{IL}			42	mA
		MM4204 T_A = 0°C, $\overline{CS}$ = V_{IH}, Power Saver = V_{IL}			52	mA
		MM5204 T_A = 0°C, $\overline{CS}$ = V_{IH}, Power Saver = V_{IH}			10	mA
		MM4204 T_A = 0°C, $\overline{CS}$ = V_{IH}, Power Saver = V_{IH}			12	mA

ac electrical characteristics

T_A within operating temperature range, V_{LL} = 0V, V_{BB} = PROGRAM = V_{SS}, MM4204: V_{SS} = 5.0V ±10%, V_{DD} = −12V ±10%, MM5204: V_{SS} = 5.0V ±5%, V_{DD} = −12V ±5%, unless otherwise noted.

PARAMETER		CONDITIONS	MIN	TYP (Note 7)	MAX	UNITS
t_{ACC}	Access Time					
	MM5204	T_A = 70°C, (Note 4)		0.75	1.0	μs
	MM4204	T_A = 85°C, (Note 4)			1.25	μs
t_{PO}	Power Saver Set-Up Time					
	MM5204				1.8	μs
	MM4204				2.0	μs
t_{CO}	Chip Select Delay					
	MM5204				500	ns
	MM4204				600	ns
t_{OH}	Data Hold Time		30	50		ns
t_{ODC}	Chip Select Deselect Time					
	MM5204		30	300	500	ns
	MM4204		30	300	600	ns
t_{ODP}	Power Saver Deselect Time					
	MM5204		30	300	500	ns
	MM4204		30	300	600	ns
C_{IN}	Input Capacitance (All Inputs)	V_{IN} = V_{SS}, f = 1.0 MHz, (Note 2)		5.0	8.0	pF
C_{OUT}	Output Capacitance (All Outputs)	V_{OUT} = V_{SS}, $\overline{CS}$ = V_{IH}, f = 1.0 MHz, (Note 2)		8.0	15	pF

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programmer electrical characteristics

T_A = 25°C, V_{SS} = $\overline{CS}$ = Power Saver = 0V, V_{LL} = 0V to −14V, unless otherwise specified, (Note 5).

PARAMETER		CONDITIONS	MIN	TYP (Note 7)	MAX	UNITS
I_{LD}	Data Input Load Current	V_{IN} = −18V			−10	mA
I_{ALD}	Address Input Load Current	V_{IN} = −50V			−10	mA
I_{LP}	Program Load Current	V_{IN} = −50V			−10	mA
I_{LBB}	V_{BB} Load Current				50	mA
I_{LDD}	V_{DD} Load Current	V_{DD} = PROGRAM = −50V			−200	mA
V_{IHP}	Address Data and Power Saver Input High Voltage		−2.0		0.3	V
V_{ILP}	Address Input Low Voltage		−50		−11	V
	Data Input Low Voltage		−18		−11	V
V_{DHP}	V_{DD} and Program High Voltage		−2.0		0.5	V
V_{DLP}	V_{DD} and Program Low Voltage		−50		−48	V
V_{BLP}	V_{BB} Low Voltage		0		0.4	V
V_{BHP}	V_{BB} High Voltage		11.4		12.6	V
V_{DD}	Pulse Duty Cycle				25	%
t_{PW}	Program Pulse Width		0.5		5.0	ms
t_{DS}	Data and Address Set-Up Time		40			μs
t_{DH}	Data and Address Hold Time		0			μs
t_{SS}	Pulsed V_{DD} Set-Up Time		40		100	μs
t_{SH}	Pulsed V_{DD} Hold Time		1.0			μs
t_{BS}	Pulsed V_{BB} Set-Up Time		1.0			μs
t_{BH}	Pulsed V_{BB} Hold Time		1.0			μs
t_{PSS}	Power Saver Set-Up Time		1.0			μs
t_{PSH}	Power Saver Hold Time		1.0			μs
t_R, t_F	V_{DD}, Program, Address and Data Rise and Fall Time				1.0	μs

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: Capacitance is guaranteed by periodic testing.

Note 3: Positive true logic notation is used except on data inputs during programming
Logic "1" = most positive voltage level
Logic "0" = most negative voltage level

Note 4: t_{ACC} = 1000 ns + 25 (N-1) where N is the number of devices wire−OR'd together.

Note 5: The program cycle should be repeated until the data reads true, then over-programmed 5 times that number of cycles. (Symbolized as X + 5X programming).

Note 6: The EROM is initially programmed with all "0's." A V_{IHP} on any data input B0−B7 will leave the stored "0's" undisturbed, and a V_{ILP} on any data input B0−B7 will write a logic "1" into that location.

Note 7: Typical values are for nominal voltages and T_A = 25°C, unless otherwise specified.

erase specification

The recommended dosage of ultraviolet light exposure is 6W sec/cm^2.

programming

The MM4204/MM5204 is normally shipped in the unprogrammed state. All 4096-bits are at logic "0" state. The table of electrical programming characteristics and *Figure 2* give the conditions for programming of the device. In the program mode the device effectively becomes a RAM with the 512 word locations selected by address inputs A0−A8. Data inputs are B0−B7 and write operation is controlled by pulsing the Program input. Since the EROM is initially shipped with all "0's," a V_{IHP} on any data input B0−B7 will leave the stored "0's" undisturbed and a V_{ILP} on any data input B0−B7 will write a logic "1" into that location.

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MM1742 2048-bit read only memory

general description

The MM1742 is a 2048-bit static Read Only Memory which is electrically programmable and uses silicon gate technology to achieve bipolar compatibility. The device is a non-volatile memory organized as 256 8-bit words. Programming of the memory is accomplished by storing a charge in a cell location by applying a −47V pulse. Although a PROM die is used, factory programming is required.

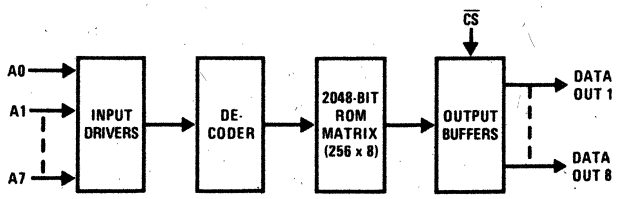
features

- Electrically programmed for fast turn-around
- Fully decoded, 256 x 8 organization
- Bipolar compatible
- TRI-STATE® outputs
- Pin compatible with the MM1702A, C1702A, and C1302.

applications

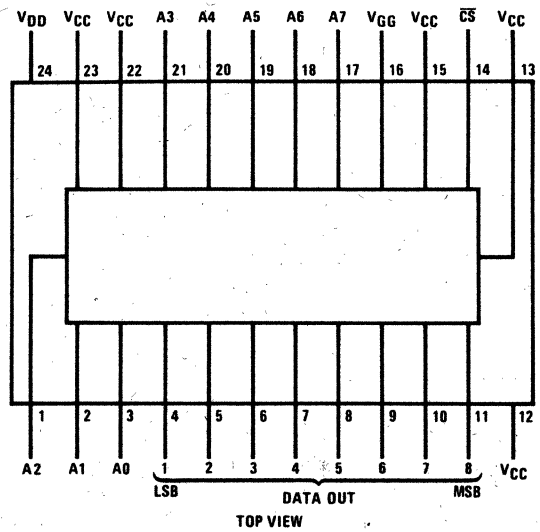
- Code conversion
- Table look-up
- Micro-programming
- Character generator
- Random logic synthesis

block and connection diagrams



Note: In the read mode a logic "1" at the address inputs and data outputs is a high and logic "0" is a low.

Dual-In-Line Package



Pin Names

A0–A7	Address Inputs
$\overline{CS}$	Chip Select Input
$D_{OUT1} - D_{OUT8}$	Data Outputs

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absolute maximum ratings (Note 1)

Ambient Temperature	0°C to +70°C
Storage Temperature	−65°C to +125°C
Power Dissipation	2W
Read Operation	
Input Voltages and Supply Voltages with Respect to V_{CC}	+0.5V to −20V
Lead Temperature (Soldering, 10 seconds)	300°C

dc characteristics

T_A = 0°C to +70°C, V_{CC} = 5V ±5%, V_{DD} = −9V ±5%, V_{GG} = −9V ±5%, unless otherwise noted. Typical values are at nominal voltages and T_A = 25°C. (Note 2)

PARAMETER		CONDITIONS	MIN	TYP	MAX	UNITS
I_{LI}	Address and Chip Select Input Load Current	V_{IN} = 0V			1	μA
I_{LO}	Output Leakage Current	V_{OUT} = 0V, $\overline{CS}$ = V_{CC} − 2			1	μA
I_{DD0}	Power Supply Current	V_{GG} = V_{CC}, $\overline{CS}$ = V_{CC} − 2 I_{OL} = 0 mA, T_A = 25°C, (Note 2)		5	10	mA
I_{DD1}	Power Supply Current	$\overline{CS}$ = V_{CC} − 2, I_{OL} = 0 mA, T_A = 25°C		35	50	mA
I_{DD2}	Power Supply Current	$\overline{CS}$ = 0, I_{OL} = 0 mA, T_A = 25°C		32	46	mA
I_{DD3}	Power Supply Current	$\overline{CS}$ = V_{CC} − 2, I_{OL} = 0 mA, T_A = 0°C		38.5	60	mA
I_{CF1}	Output Clamp Current	V_{OUT} = −1V, T_A = 0°C		8	14	mA
I_{CF2}	Output Clamp Current	V_{OUT} = −1V, T_A = 25°C			13	mA
I_{GG}	Gate Supply Current				1	μA
V_{IL1}	Input Low Voltage for TTL Interface		−1		V_{CC}−4.1	V
V_{IL2}	Input Low Voltage for MOS Interface		V_{DD}		V_{CC}−6	V
V_{IH}	Address and Chip Select Input High Voltage		V_{CC}−2		V_{CC}+0.3	V
I_{OL}	Output Sink Current	V_{OUT} = 0.45V	1.6	4		mA
I_{OH}	Output Source Current	V_{OUT} = 0V	−2			mA
V_{OL}	Output Low Voltage	I_{OL} = 1.6 mA		−0.7	0.45	V
V_{OH}	Output High Voltage	I_{OH} = −100μA	3.5	4.5		V

Note 1: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and and functional operation of the device at these or at any other condition above those indicated in the operational sections of this specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

Note 2: Power-Down Option: V_{GG} may be clocked to reduce power dissipation. The average I_{DD} will vary between I_{DD0} and I_{DD1} depending on the V_{GG} duty cycle (see typical characteristics). For this option, please specify MM1742ALJ.

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ac characteristics

T_A = 0°C to +70°C, V_{CC} = 5V ±5%, V_{DD} = −9V ±5%, V_{GG} = −9V ±5%, unless otherwise noted.

PARAMETER		MIN	TYP	MAX	UNITS
Freq.	Repetition Rate			1	MHz
t_{0H}	Previous Read Data Valid			100	ns
t_{ACC}	Address to Output Delay		0.7	1	μs
t_{DVGG}	Clocked V_{GG} Set-Up, (Note 1)	1			μs
t_{CS}	Chip Select Delay			100	ns
t_{CO}	Output Delay From $\overline{CS}$			900	ns
t_{OD}	Output Deselect			300	ns
t_{OHC}	Data Out Hold in Clocked V_{GG} Mode, (Note 1)			5	μs

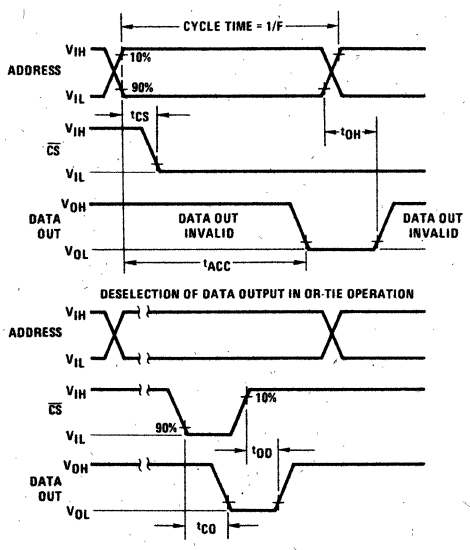
capacitance characteristics T_A = 25°C (Note 3)

PARAMETER		CONDITIONS		MIN	TYP	MAX	UNITS
C_{IN}	Input Capacitance	All Unused	$V_{IN} = V_{CC}$		8	15	pF
C_{OUT}	Output Capacitance	Pins Are	$\overline{CS} = V_{CC}$		10	15	pF
C_{VGG}	V_{GG} Capacitance, (Note 1)	At ac Ground	$V_{OUT} = V_{CC}$ $V_{GG} = V_{CC}$			30	pF

Note 3: This parameter is periodically sampled and is not 100% tested.

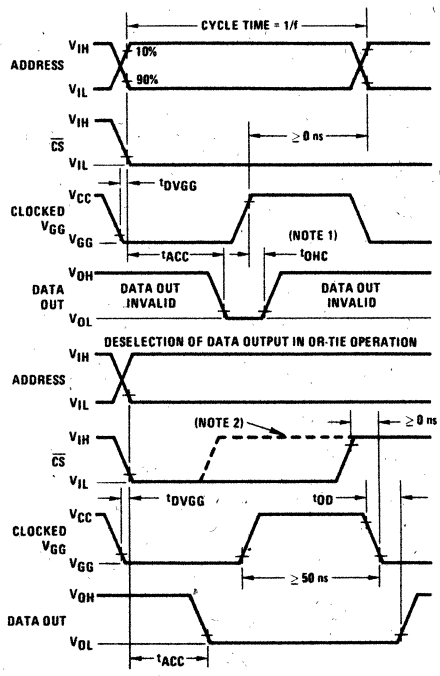
read operation switching time waveforms

(a) Constant V_{GG} Operation



Conditions of Test:
Input pulse amplitudes: 0–4V, t_r, $t_f \leq 50$ ns.
Output load is 1 TTL gate; measurements made at output of TTL gate ($t_{PD} \leq 15$ ns,) C_L = 15 pF.

(b) Power-Down Option (Note 1)



Note 1: The output will remain valid for t_{OHC} as long as clocked V_{GG} is at V_{CC}. An address change may occur as soon as the output is sensed (clocked V_{GG} may still be at V_{CC}). Data becomes invalid for the old address when clocked V_{GG} is returned to V_{GG}.

Note 2: If $\overline{CS}$ makes a transition from V_{IL} to V_{IH} while clocked V_{GG} is at V_{GG}, then deselection of output occurs at t_{OD} as shown in static operation with constant V_{GG}.

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MM2316A 16,384-bit read only memory

general description

The MM2316A is a static MOS 16,384-bit read-only memory organized in a 2048-word-by-8-bit format. It is fabricated using N-channel enhancement and depletion-mode silicon-gate technology which provides complete DTL/TTL compatibility and single power-supply operation.

Three programmable chip selects controlling the TRI-STATE® outputs allow for memory expansion.

Programming of the memory array and chip-select active levels is accomplished by changing one mask during fabrication.

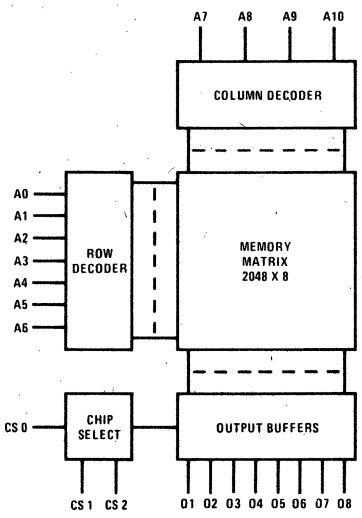
features

- Fully decoded
- Single 5V power supply
- Inputs and outputs TTL compatible
- Static operation
- TRI-STATE outputs for bus interface
- Programmable chip selects
- 2048 word by 8-bit organization
- Maximum access time—450 ns

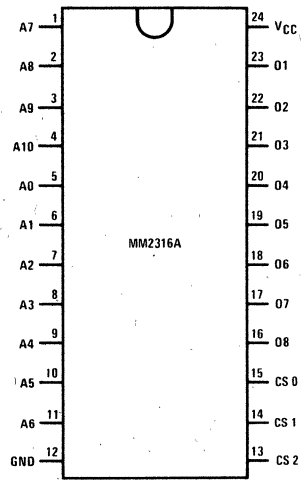
applications

- Microprogramming
- Control logic
- Table look-up

block and connection diagrams

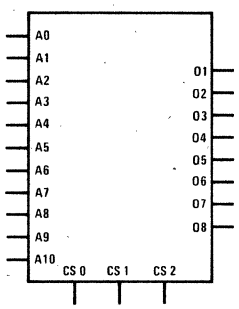


Dual-In-Line Package

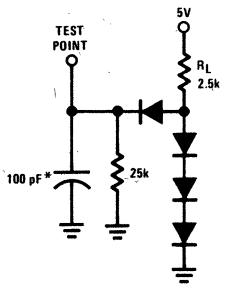


TOP VIEW

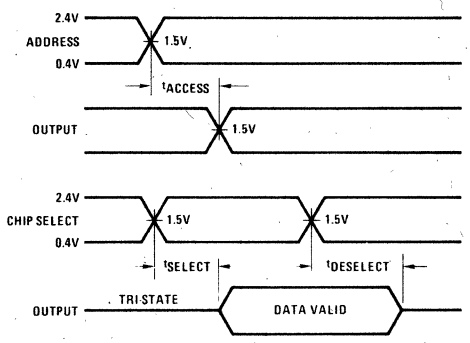
logic symbol



ac test circuit and switching time waveforms



*Includes jig capacitance



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absolute maximum ratings (Note 1)

Voltage at Any Pin	−0.5V to +7V
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Power Dissipation	1W
Lead Temperature (Soldering, 10 seconds)	300°C

dc electrical characteristics (T_A within operating temperature range, V_{CC} = 5V ±5%, unless otherwise noted).

PARAMETER (Note 3)	CONDITIONS	MIN	TYP (Note 4)	MAX	UNITS
Input Current (I_{LI})	V_{IN} = 0 to V_{CC}			10	μA
Logical "1" Input Voltage (V_{IH})		2.0		V_{CC}+1.0	V
Logical "0" Input Voltage (V_{IL})		−0.5		0.8	V
Logical "1" Output Voltage (V_{OH})	I_{OH} = −100 μA	2.2			V
Logical "0" Output Voltage (V_{OL})	I_{OL} = 2 mA			0.45	V
Output Leakage Current (I_{LOH})	V_{OUT} = 4V, CS = 2.2V			10	μA
Output Leakage Current (I_{LOL})	V_{OUT} = 0.45V, CS = 2.2V			−20	μA
Power Supply Current (I_{CC1}) (Note 4)	All Inputs = 5.25V, Data Output Open		40	98	mA

capacitance

PARAMETER (Note 3)	CONDITIONS	MIN	TYP (Note 4)	MAX	UNITS
Input Capacitance (All Inputs) (C_{IN}), (Note 4)	V_{IN} = 0V, T_A = 25°C, f = 1 MHz, (Note 2)			7.5	pF
Output Capacitance (C_{OUT}), (Note 4)	V_{OUT} = 0V, T_A = 25°C, f = 1 MHz, (Note 2)			15.0	pF

ac electrical characteristics

(T_A within operating temperature range, V_{CC} = 5V ±5%, unless otherwise specified).
See ac test circuit and switching time waveforms.

PARAMETER (Note 3)	CONDITIONS	MIN	TYP (Note 4)	MAX	UNITS
t_{ACCESS}	See ac Load Circuit. All Times Measured to 1.5V Level with t_r and t_f of Input < 20 ns			450	ns
t_{SELECT}	See ac Load Circuit. All Times Measured to 1.5V Level with t_r and t_f of Input < 20 ns			300	ns
$t_{DESELECT}$	See ac Load Circuit. All Times Measured to 1.5V Level with t_r and t_f of Input < 20 ns			300	ns

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: Capacitance is guaranteed by periodic testing.

Note 3: Positive true logic notation is used: logical "1" = most positive voltage level, logical "0" = most negative voltage level.

Note 4: Typical values are for T_A = 25°C and nominal supply voltage.

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MM4242/MM5242 1024 x 8-bit ROM
MM4245/MM5245 2048 x 4-bit ROM

general description

These static, 8192-bit ROMs are fabricated using N-Channel enhancement and depletion mode silicon gate technology. This provides complete DTL/TTL compatibility and single power supply operation.

Chip select inputs control the TRI-STATE® outputs and allow for memory expansion. The chip select code is programmed at the same time as the memory matrix and a code of 1:16 for the MM4242/MM5242 and 1:8 for the MM4245/MM5245 must be selected.

features

- Fully decoded
- Single +5V supply
- All inputs and outputs directly DTL/TTL compatible
- Static operation
- TRI-STATE outputs for bus interface
- Programmable chip selection
- Maximum access time 450 ns (MM5242/MM5245)
- Pin compatible with National's 4k and 16k ROMs

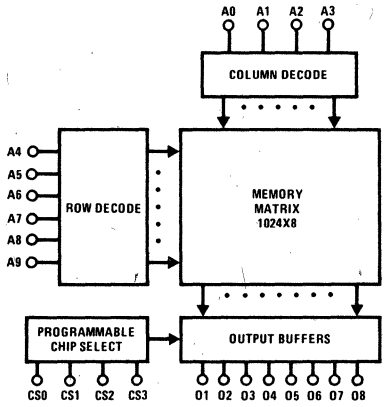
applications

- Microprogramming
- Control logic
- Random logic synthesis
- Table lookup

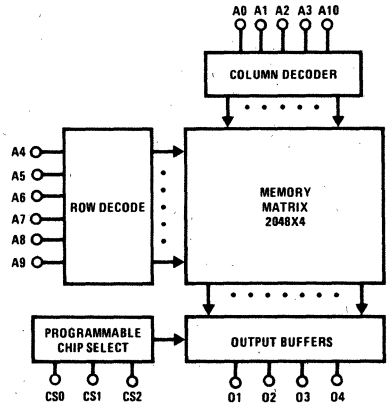
	Military	Commercial	Organization	Package
MM4242	X		1024 x 8	J
MM5242		X	1024 x 8	N, J
MM4245	X		2048 x 4	J
MM5245		X	2048 x 4	N, J

block and connection diagrams

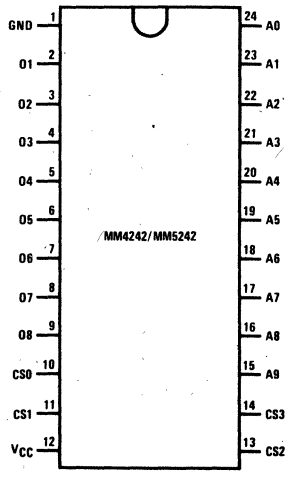
MM4242/MM5242



MM4245/MM5245

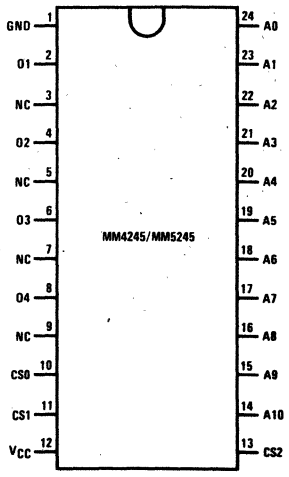


Dual-In-Line Package



TOP VIEW

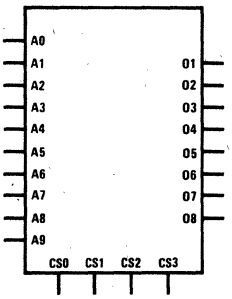
Dual-In-Line Package



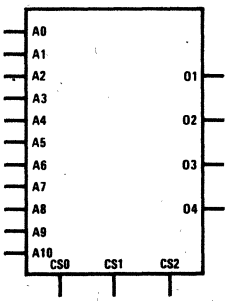
TOP VIEW

logic symbols

MM4242/MM5242



MM4245/MM5245



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absolute maximum ratings

(Note 1)

Voltage At Any Pin	−0.5V to +7.0V
Storage Temperature Range	−65°C to +150°C
Power Dissipation	1.0 W
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
MM4242, MM4245	4.5	5.5	V
MM5242, MM5245	4.75	5.25	V
Ambient Temperature (T_A)			
MM4242, MM4245	−55	+125	°C
MM5242, MM5245	0	+70	°C
Logical "0" Input Voltage (Low)	−0.5	+0.65	V
Logical "1" Input Voltage (High)	2.0	V_{CC}	V

dc electrical characteristics (Note 2)

PARAMETER		CONDITIONS	MM4242, 45			MM5242, 45			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IH}	Logic "1" Input Voltage		2.0		V_{CC}	2.0		V_{CC}	V
V_{IL}	Logic "0" Input Voltage		−0.5		0.65	−0.5		0.65	V
V_{OH}	Logic "1" Output Voltage	I_{OH} = −200 μA	2.4			2.4			V
V_{OL}	Logic "0" Output Voltage	I_{OL} = 3.2 mA			0.4			0.4	V
I_{LI}	Input Current	V_{IN} = 0 to V_{CC}			2.5			2.5	μA
I_{LOH}	Output Leakage Current	V_{OUT} = 2.4V, (Note 3)			10			10	μA
I_{LOL}	Output Leakage Current	V_{OUT} = 0.45V, (Note 3)	−10			−10			μA
I_{CC}	Power Supply Current	All Inputs = V_{CC} Data Out Open			130			130	mA

capacitance

PARAMETER		CONDITIONS	MM4242/5242			MM4245/5245			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
C_{IN}	Input Capacitance	V_{IN} = 0V, T_A = 25°C, f = 1.0 MHz, (Note 4)			7.5			7.5	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0V, T_A = 25°C, f = 1.0 MHz, (Note 4)			15.0			22.0	pF

ac electrical characteristics (With Standard Load)

PARAMETER		CONDITIONS	MM4242, 45			MM5242, 45			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{ACCESS}	Access Time	*(Figure 1)*		250	575		250	450	ns
t_{SELECT}	Output Enable Time	*(Figure 2)*		100	300		100	200	ns
$t_{DESELECT}$	Output Disable Time	*(Figure 2)*		75	150		75	125	ns

Note 1: "Absolute Maximum Ratings" are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

Note 2: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

Note 3: Chip select inputs such that outputs are TRI-STATE.

Note 4: Capacitance is guaranteed by periodic testing.

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MM4243/MM5243 2048-bit read only memory

general description

The MM4243/MM5243 is a 2048-bit static Read Only Memory which is electrically programmable and uses silicon gate technology to achieve bipolar compatibility. The device is a non-volatile memory organized as 256 8-bit words or 512 4-bit words. Programming of the memory is accomplished by storing a charge in a cell location by applying a −50V pulse. Although a PROM die is used, factory programming is required. Separate output supply lead is provided to reduce internal power dissipation in the output stage (V_{LL}).

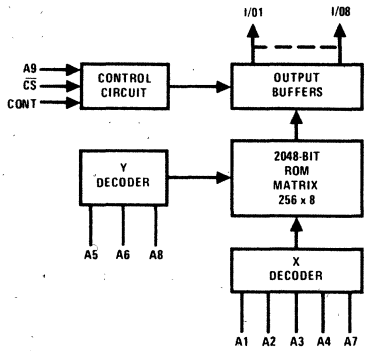
features

- Electrically programmed for fast turn-around
- Bipolar compatibility — +5V, −12V operation
- High speed operation — 1μs max access time
- Pin compatible with MM5203Q, EPROM and the MM5213 masked ROM
- Static operation — no clocks required
- Common data busing (TRI-STATE® output)
- Chip select output control
- 256 x 8 or 512 x 4 organization

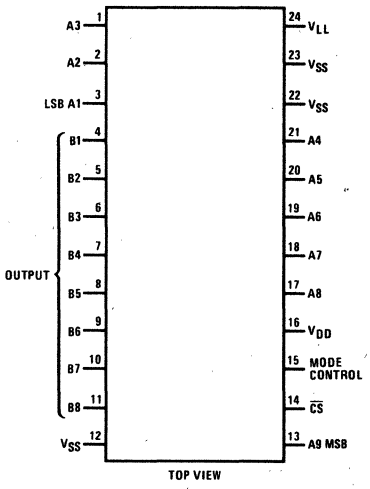
applications

- Code conversion
- Random logic synthesis
- Table look-up
- Character generator
- Micro-programming

block and connection diagrams

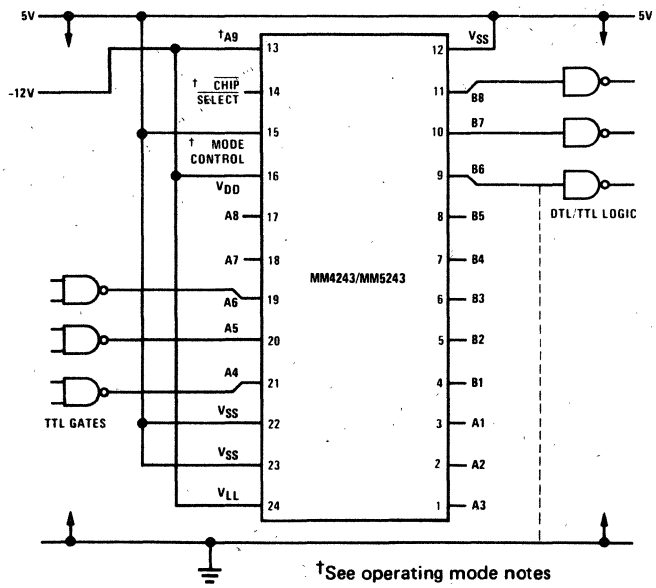


Dual-In-Line Package



typical application

256 x 8 PROM Showing TTL Interface



†See operating mode notes

Operating Modes

256 x 8 ROM connection (shown)
Mode Control — HIGH (V_{SS})
A9 — LOW

512 x 4 ROM connections
Mode Control — LOW (GND or V_{DD})
A9 — Logic HIGH enables the odd (B1, B3. . .B7) outputs
A9 — Logic LOW enables the even (B2, B4. . .B8) outputs

The outputs are enabled when a logic LOW is applied to the Chip Select line.

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absolute maximum ratings

All Input or Output Voltages with Respect to V_{SS}	0.3V to −20V
Power Dissipation	1W
Operating Temperature Range	
MM4243	−55°C to +85°C
MM5243	0°C to +70°C
Storage Temperature Range	−65°C to +125°C
Lead Temperature (Soldering, 10 seconds)	300°C

electrical characteristics

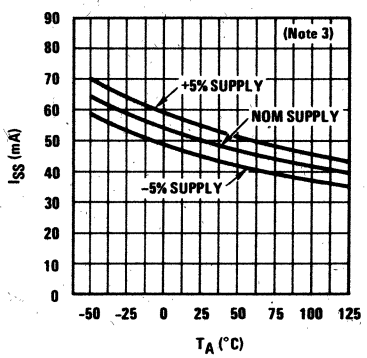
T_A within operating temperature range, V_{SS} = 5V ±5%, V_{DD} = V_{LL} = −12V ±5%, unless otherwise noted.

	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
I_{LI}	Input Current	V_{IN} = 0V			1	μA
I_{LO}	Output Leakage	V_{OUT} = 0V, $\overline{CS}$ = V_{SS} − 2			1	μA
I_{SS}	Power Supply Current	$\overline{CS}$ = V_{SS} − 2, T_A = 25°C		35	55	mA
V_{IL}	Input LOW Voltage		V_{SS}−10		V_{SS}−4	V
V_{IH}	Input HIGH Voltage		V_{SS}−2		V_{SS}+0.3	V
V_{OL}	Output LOW Voltage	1.6 mA sink, −12.6V < V_{LL} <−3V			0.4	V
I_{CF}	Output Clamp Current	V_{OUT} = −1V, T_A = 0°C, (Note 4)				
		V_{LL} = −3V		3.5	6	mA
		V_{LL} = −12.6V		8	15	mA
V_{OH}	Output HIGH Voltage	0.8 mA source	2.4			V
T_{OH}	Data Hold Time	(Min Access Time), *(Figures 1 and 2)*			100	ns
T_{ACC}	Access Time	T_A = 25°C, (Note 2), *(Figures 1 and 2)*		0.7	1	μs
T_{CO}	Chip Select Time	*(Figures 1 and 3)*			500	ns
T_{OD}	Chip Deselect Time	*(Figures 1 and 3)*			500	ns
t_{CS}	Allowable Chip Select Delay	*(Figures 1 and 2)* Allowable delay in selecting chip after change of address without affecting access time			100	ns
C_{IN}	Input Capacitance	V_{IN} = V_{SS}, f = 1 MHz, (Note 1)		8	15	pF
C_{OUT}	Output Capacitance	V_{OUT} = V_{SS}, $\overline{CS}$ = V_{SS} − 2, f = 1 MHz, (Note 1)		8	15	pF

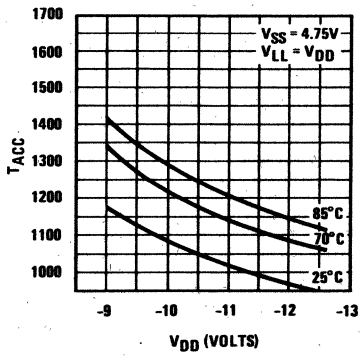
Note 1: Capacitances are not tested on a production basis but are periodically sampled.
Note 2: T_{ACC} = 1000 ns + 25(N−1) where N is the number of chips wired-OR together.
Note 3: Measured under continuous operation.
Note 4: I_{CF} flows out the V_{LL} pin, it does not flow out the V_{DD} pin.

typical performance characteristics

Maximum Supply Current I_{SS} as a Function of Temperature



Maximum Access Time (T_{ACC}) as a Function of V_{DD} Supply Voltage



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MM4244/MM5244 4096-bit read only memory

general description

The MM4244/MM5244 is a 4096-bit static Read Only Memory which is electrically programmable and uses silicon gate technology to achieve bipolar compatibility. The device is a non-volatile memory organized as 512 words by 8 bits per word. Programming of the memory is accomplished by storing a charge in a cell location by applying a −50V pulse. Although a PROM die is used, factory programming is required. A logic input, "Power Saver," is provided which gives a 5:1 decrease in power when the memory is not being accessed.

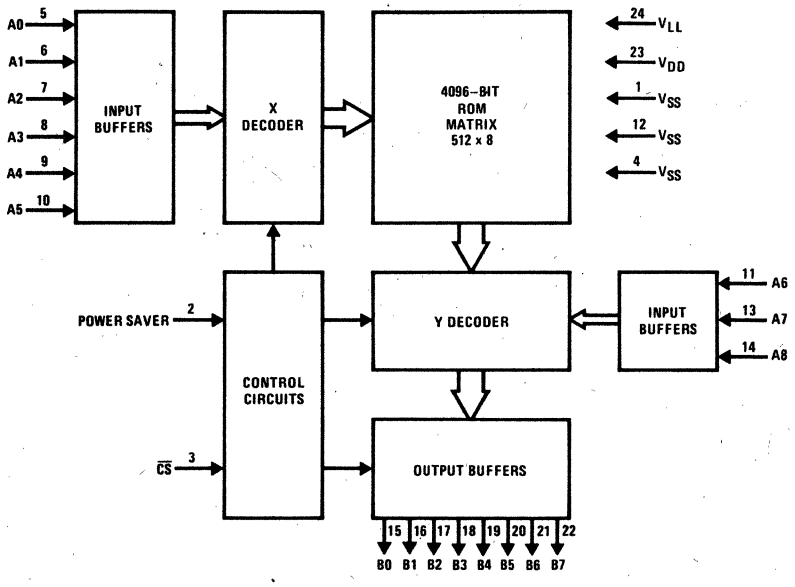
features

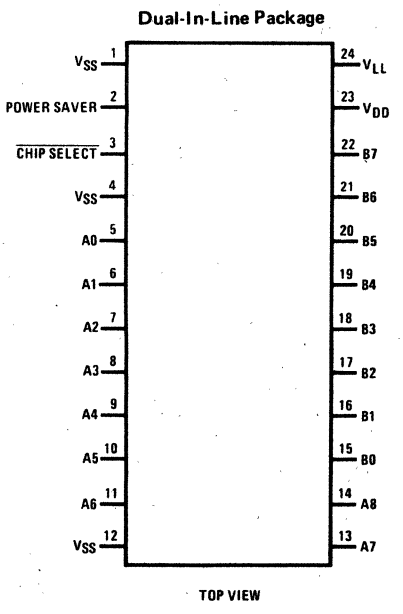
- Electrically programmed for fast turn-around
- Fast access time
  - MM4244 1.25μs
  - MM5244 1μs
- DTL/TTL compatibility
- Pin compatible with the MM5204 and the MM5214
- Standard power supplies 5.0V, −12V
- Static operation—no clock required
- Easy memory expansion—TRI-STATE® output Chip Select input ($\overline{CS}$)
- Low power dissipation
- "Power Saver" control for low power applications

applications

- Code conversion
- Random logic synthesis
- Table look-up
- Character generator
- Microprogramming
- Electronic keyboards

block and connection diagrams





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absolute maximum ratings (Note 1)

All Input or Output Voltages with Respect to V_{SS}	0.3V to −20V	Operating Temperature Range MM5244	0°C to +70°C
Power Dissipation	750 mW	MM4244	−55°C to +85°C
Lead Temperature (Soldering, 10 seconds)	300°C	Storage Temperature Range	−65°C to +125°C

dc electrical characteristics

T_A within operating temperature range, V_{LL} = 0V, MM4244: V_{SS} = 5V ±10%, V_{DD} = −12V ±10%, MM5244: V_{SS} = 5V ±5%, V_{DD} = −12V ±5%, unless otherwise noted.

PARAMETER		CONDITIONS	MIN	TYP (Note 5)	MAX	UNITS
V_{IL}	Input Low Voltage		V_{DD}−14		V_{SS}−4.2	V
V_{IH}	Input High Voltage		V_{SS}−1.5		V_{SS}+0.3	V
I_{LI}	Input Current	V_{IN} = 0V			1	μA
V_{OL}	Output Low Voltage	I_{OL} = 1.6 mA	V_{LL}		0.4	V
V_{OH}	Output High Voltage	I_{OH} = −0.8 mA	2.4		V_{SS}	V
I_{LO}	Output Leakage Current	V_{OUT} = 0V, $\overline{CS}$ = V_{IH}			1	μA
I_{DD}	Power Supply Current	T_A = 0°C, $\overline{CS}$ = V_{IH}				
	MM5244	Power Saver = V_{IL}		28	40	mA
	MM4244	Power Saver = V_{IL}			50	mA
	MM5244	Power Saver = V_{IH}		6	8	mA
	MM4244	Power Saver = V_{IH}			10	mA
I_{SS}	MM5244	Power Saver = V_{IL}			42	mA
	MM4244	Power Saver = V_{IL}			52	mA
	MM5244	Power Saver = V_{IH}			10	mA
	MM4244	Power Saver = V_{IH}			12	mA

ac electrical characteristics

T_A within operating temperature range, V_{LL} = 0V, MM4244: V_{SS} = 5V ±10%, V_{DD} = −12V ±10%, MM5244: V_{SS} = 5V ±5V, V_{DD} = −12V ±5%, unless otherwise noted.

PARAMETER		CONDITIONS	MIN	TYP (Note 5)	MAX	UNITS
t_{ACC}	Access Time	*(Figure 1)*, (Note 4)				
	MM5244	T_A = 70°C		0.75	1	μs
	MM4244	T_A = 85°C			1.25	μs
t_{PO}	Power Saver Set-Up Time	*(Figure 1)*				
	MM5244				1.8	μs
	MM4244				2	μs
t_{CO}	Chip Select Delay	*(Figure 1)*				
	MM5244				500	ns
	MM4244				600	ns
t_{OH}	Data Hold Time	*(Figure 1)*	30	50		ns
t_{ODC}	Chip Select Deselect Time	*(Figure 1)*				
	MM5244		30	300	500	ns
	MM4244		30	300	600	ns
t_{ODP}	Power Saver Deselect Time	*(Figure 1)*				
	MM5244		30	300	500	ns
	MM4244		30	300	600	ns
C_{IN}	Input Capacitance (All Inputs)	V_{IN} = V_{SS}, f = 1 MHz, (Note 2)		5	8	pF
C_{OUT}	Output Capacitance (All Outputs)	V_{OUT} = V_{SS}, CS = V_{IH}, f = 1 MHz, (Note 2)		8	15	pF

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: Capacitance is guaranteed by periodic testing.

Note 3: Positive true logic notation is used
Logic "1" = most positive voltage level
Logic "0" = most negative voltage level

Note 4: t_{ACC} = 1000 ns + 25 (N-1) where N is the number of devices wire−OR'd together.

Note 5. Typical values are for nominal voltages and T_A = 25°C, unless otherwise specified.

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Preliminary

MM4246/MM5246 2048 x 8-bit ROM
MM4247/MM5247 4096 x 4-bit ROM

general description

These static, 16,384-bit ROMs are fabricated using N-channel enhancement and depletion-mode silicon-gate technology. This provides complete DTL/TTL compatibility and single power supply operation.

Chip select inputs control the TRI-STATE® outputs and allow for memory expansion. The chip select code is programmed at the same time as the memory matrix and a code of 1:8 for the MM4246/MM5246 and 1:4 for the MM4247/MM5247 must be selected.

features

- Fully decoded
- Single +5V supply
- All inputs and outputs directly DTL/TTL compatible
- Static operation
- TRI-STATE outputs for bus interface
- Programmable chip selection
- Maximum access time 450 ns (MM5246, MM5247)
- Pin compatible with National 4k and 8k ROMs

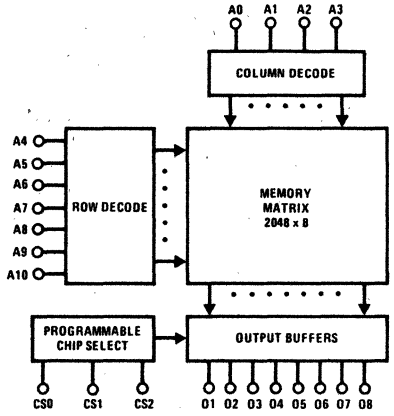
applications

- Microprogramming
- Control logic
- Random logic synthesis
- Table lookup

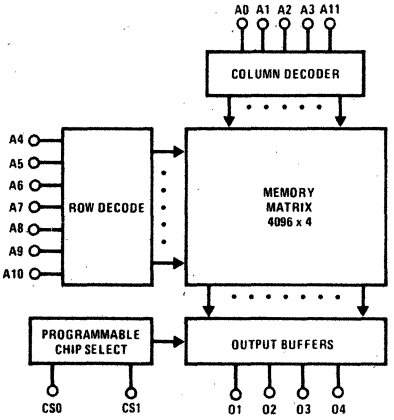
	Military	Commercial	Organization	Package
MM4246	X		2048 x 8	J
MM5246		X	2048 x 8	N, J
MM4247	X		4096 x 4	J
MM5247		X	4096 x 4	N, J

block and connection diagrams

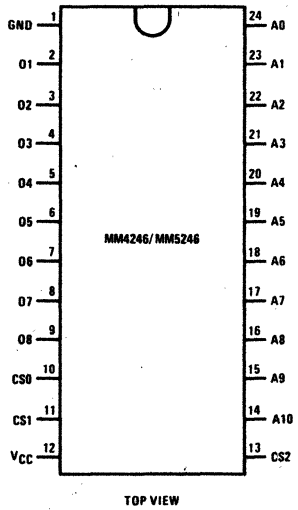
MM4246/MM5246



MM4247/MM5247

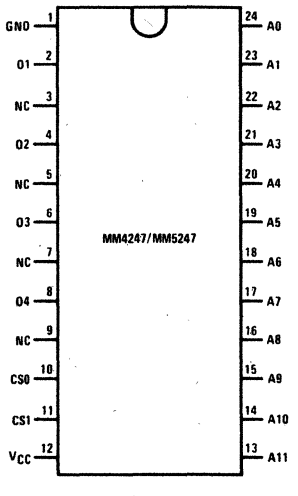


Dual-In-Line Package



TOP VIEW

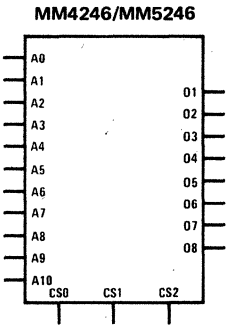
Dual-In-Line Package



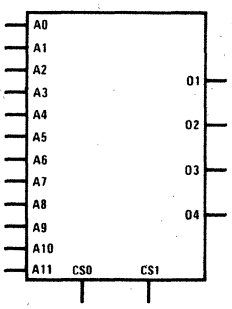
TOP VIEW

logic symbols

MM4246/MM5246



MM4247/MM5247



MM4246/MM5246 2048 x 8-bit ROM
MM4247/MM5247 4096 x 4-bit ROM

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absolute maximum ratings

(Note 1)

Voltage At Any Pin	−0.5V to +7.0V
Storage Temperature Range	−65°C to +150°C
Power Dissipation	1.0 W
Lead Temperature (Soldering, 10 seconds)	300°C

operating conditions

	MIN	MAX	UNITS
Supply Voltage (V_{CC})			
MM4246, MM4247	4.5	5.5	V
MM5246, MM5247	4.75	5.25	V
Ambient Temperature (T_A)			
MM4246, MM4247	−55	+125	°C
MM5246, MM5247	0	+70	°C
Logical "0" Input Voltage (Low)	−0.5	+0.65	V
Logical "1" Input Voltage (High)	2.0	V_{CC}	V

dc electrical characteristics (Note 2)

PARAMETER		CONDITIONS	MM4246, 47			MM5246, 47			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IH}	Logic "1" Input Voltage		2.0		V_{CC}	2.0		V_{CC}	V
V_{IL}	Logic "0" Input Voltage		−0.5		0.65	−0.5		0.65	V
V_{OH}	Logic "1" Output Voltage	I_{OH} = −200 μA	2.4			2.4			V
V_{OL}	Logic "0" Output Voltage	I_{OL} = 3.2 mA			0.4			0.4	V
I_{LI}	Input Current	V_{IN} = 0 to V_{CC}			2.5			2.5	μA
I_{LOH}	Output Leakage Current	V_{OUT} = 2.4V, (Note 3)			10			10	μA
I_{LOL}	Output Leakage Current	V_{OUT} = 0.45V, (Note 3)	−10			−10			μA
I_{CC}	Power Supply Current	All Inputs = V_{CC} Data Out Open			130			130	mA

capacitance

PARAMETER		CONDITIONS	MM4246/5246			MM4247/5247			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
C_{IN}	Input Capacitance	V_{IN} = 0V, T_A = 25°C, f = 1.0 MHz, (Note 4)			7.5			7.5	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0V, T_A = 25°C, f = 1.0 MHz, (Note 4)			15.0			22.0	pF

ac electrical characteristics (With Standard Load)

PARAMETER		CONDITIONS	MM4246, 47			MM5246, 47			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
t_{ACCESS}	Access Time	*(Figure 1)*		250	575		250	450	ns
t_{SELECT}	Output Enable Time	*(Figure 2)*		100	300		100	200	ns
$t_{DESELECT}$	Output Disable Time	*(Figure 2)*		75	150		75	125	ns

Note 1: "Absolute Maximum Ratings" are those values beyond which the device may be permanently damaged. They do not mean that the device may be operated at these values.

Note 2: These limits apply over the entire operating range unless stated otherwise. All typical values are for V_{CC} = 5V and T_A = 25°C.

Note 3: Chip select inputs such that outputs are TRI-STATE.

Note 4: Capacitance is guaranteed by periodic testing.

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NS3
BULK STORAGE MEMORY UNIT

- > Complete System
- > Semiconductor Memory
- > High Speed
- > Low Cost
- > Compact
- > Accessories

- > Up to 128K x 22 bits (256K bytes)
- > 32K x 22 bit modularity
- > Byte Control
- > 5¼" Cabinet
- > Customized Interfacing
- > Error Check and Correction
- > TTL Compatible

The NS3 is a self-contained semiconductor random access memory system with a maximum capacity of 128K x 22 bits or 256K bytes.

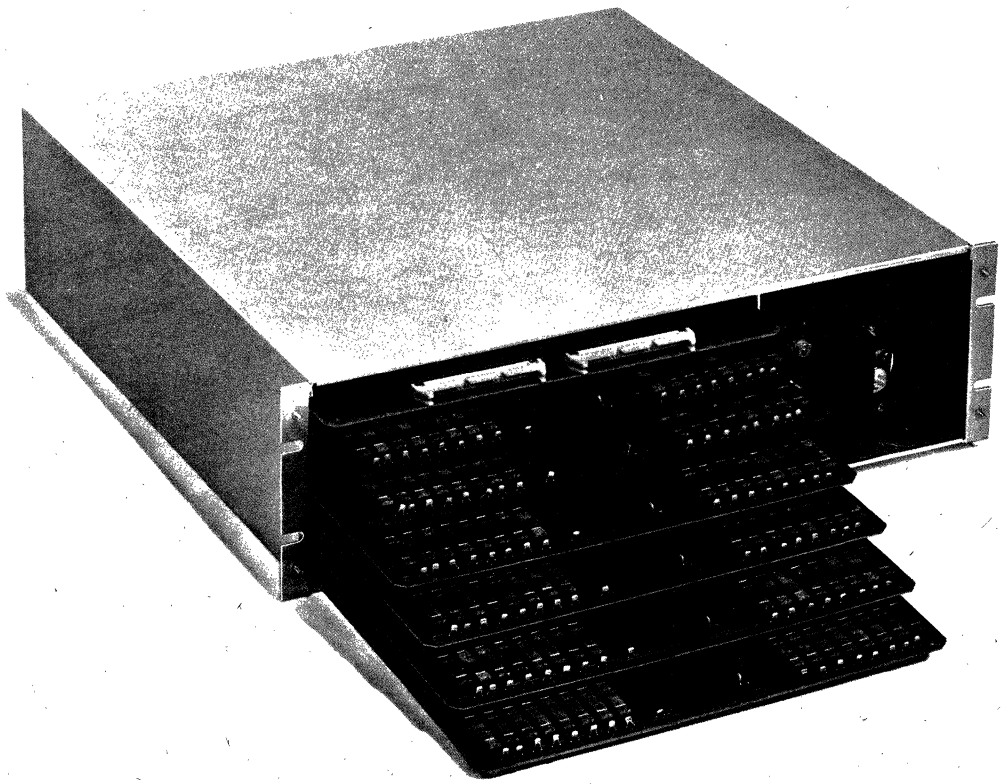
It is structured to provide a wide range of flexibility to satisfy individual systems applications.

The memory is configured in 4 modular cards. Each card has a maximum capacity of 32K x 22 bits (64K bytes). The memory can be modified to individual system requirements.

The basic storage element is a 4K dynamic RAM which provides speed, proven reliability and low cost. Memory Flexibility is achieved by board depopulation. Optional Features are provided. These include custom interfacing, error correction, and double word control (44 bits word structure).

A remote Self-Test unit is offered as an optional accessory which exercises the memory system.

The NS3 system is housed in a 5¼" cabinet and contains its own power supply.



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NS3
BULK STORAGE
MEMORY UNIT

The NS3 Memory System contains:

Custom Interface Card (optional)
This provides for a specially designed interface. A breadboard card is also available for the customer's own design.

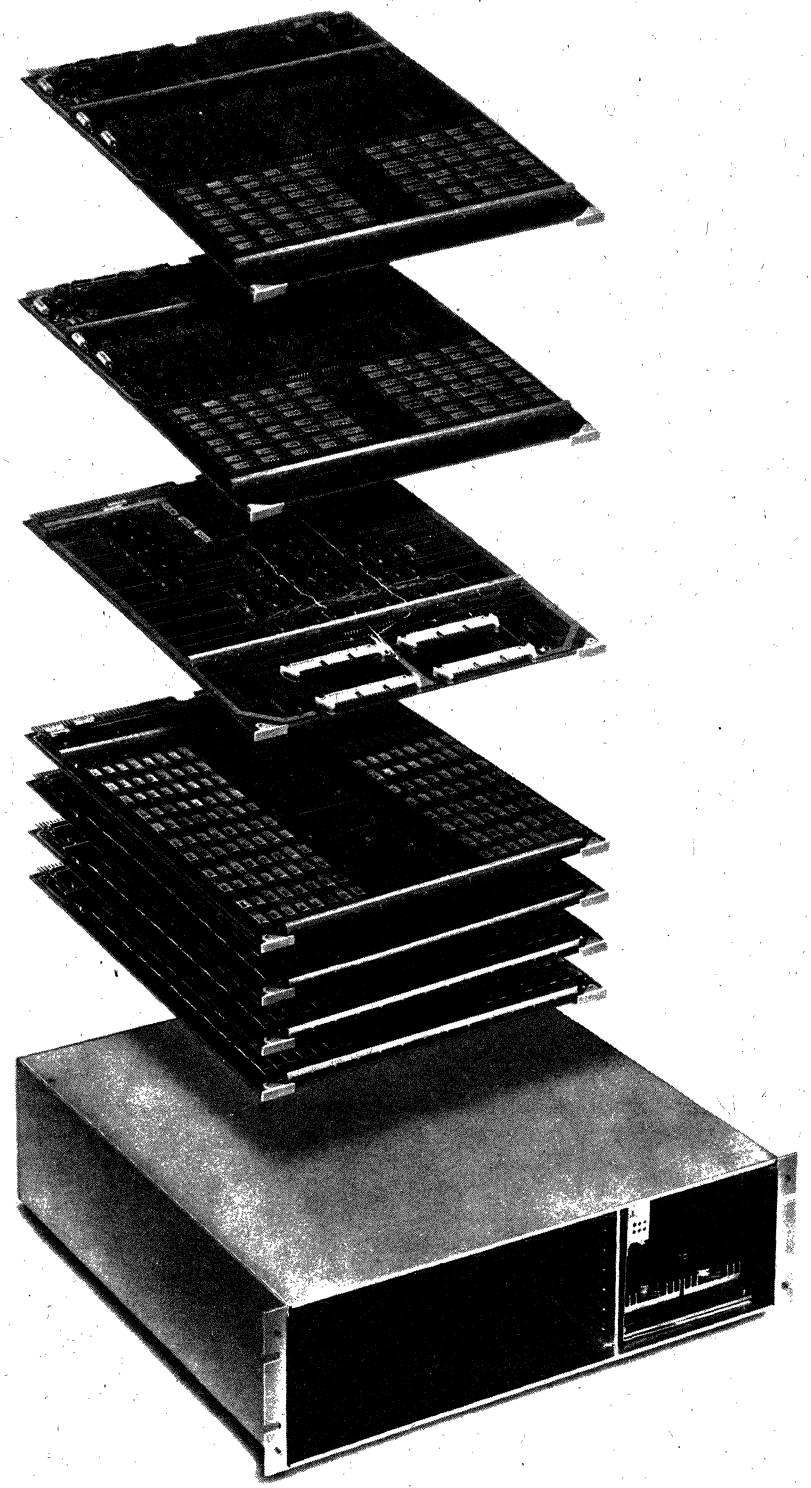
Special Features Card (optional)
This offers customized requirements such as error check and correction, double word structure, etc.

Timing and Control
This includes refresh logic which is implemented on a customized basis. *Parity generation and parity check are available as option.

Memory Storage Cards
There are up to 4 Memory Storage Cards. Each card contains up to 32K x 22 bits (64K bytes) which can be depopulated.

Cabinet and Power Unit
The cards are housed in a 5¼" cabinet which also contains a power unit as a standard feature. The system interfaces to the main system via connectors on the rear of the unit. A system interface cable can be provided as an option.

*See section on Memory refresh.



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Modes of Operation
Write
Read
Read/Modify/Write

Performance

Access Time	280ns
Read or Write Cycle	430ns
Read/Modify/Write Cycle	610ns*

*Plus user data modify time

Environment
Operating 0°C to +50°C
Non-operating −40°C to +80°C
Humidity 90% without condensation

Logic Levels
All levels are TTL compatible
Terminations are optional

Memory Refresh
This can be implemented to individual customer applications either in a synchronous mode or in an a-synchronous mode allowing handshaking with the CPU. A transparent refresh can be achieved in many applications.

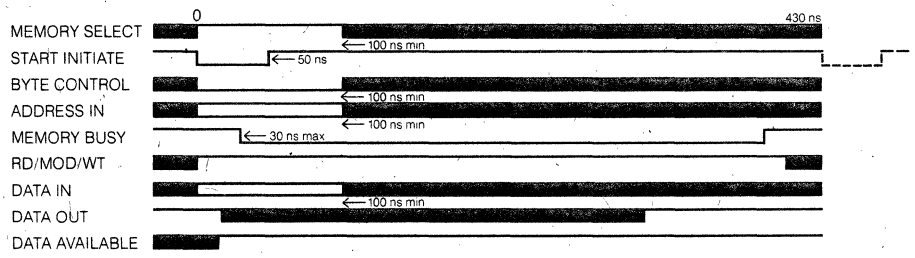
Interfacing
Up to 3 max. plugs and receptacles
Elco 90 pin (plug)
Elco 90 pin (receptacle

Mechanical
Card Size: 11.75" x 15.40"
Connectors: 2 ea. 80 pin edge connectors with pins space "125" center to center

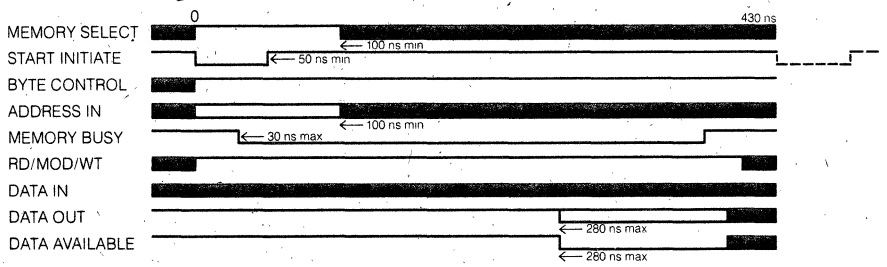
Optional Features
1 Error check and correction
2 Parity generation/Parity check
3 Double word control—44 bit word structure
4 Late data strobe
5 Custom Logic Interface
6 Custom System Interface Cables

Timing Diagrams

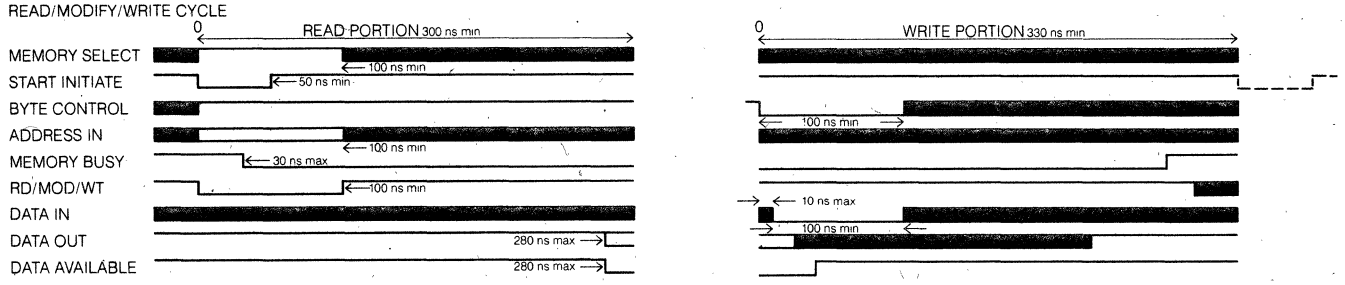
WRITE CYCLE



READ CYCLE



READ/MODIFY/WRITE CYCLE



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NS3000-1
MEMORY CARD
16K x 20 BITS

National Semiconductor
Corporation
2900 Semiconductor Drive
Santa Clara, California 95051
(408) 732-5000
TWX (910) 339-9240

Output Signals
1 Data Out (DO)
2 Data Available (DA)
3 Memory Busy (MB)

Performance
Access Time:	280 ns
Read or Write Cycle:	430 ns
Read/Modify/Write Cycle:	610 ns*

*Plus user data modify time

Input Signals
1 Initiate pulse (RP)
2 Byte control levels (BLC1, BLC2)
3 Split Cycle (SC)
4 Write pulse (WP)
5 Configuration Option (4 lines)
6 Address In (AI)
7 Extended Address In (XAI)
8 Data In (DI)
9 Memory Protect (MP)

Logic Levels
All levels are negative true TTL compatible. Terminations are optional.

Special Options
These can be added on a customized basis.
1 Parity Check
2 Parity Generation
3 Data Available Reset—permits Data available (DA) to be gated within the memory cycle. It can be used to release the data buss in a shared system.

Memory Organization
1 Memory Storage
2 Timing and Control
3 Refresh Circuitry
4 Optional Features
Note: The memory size can be reduced by board depopulation.

Memory Refresh
This can be implemented to individual customer applications either in a synchronous mode or in an asynchronous mode allowing hand shaking with the CPU.

Modes of Operation
Read
Write
Read/Modify/Write

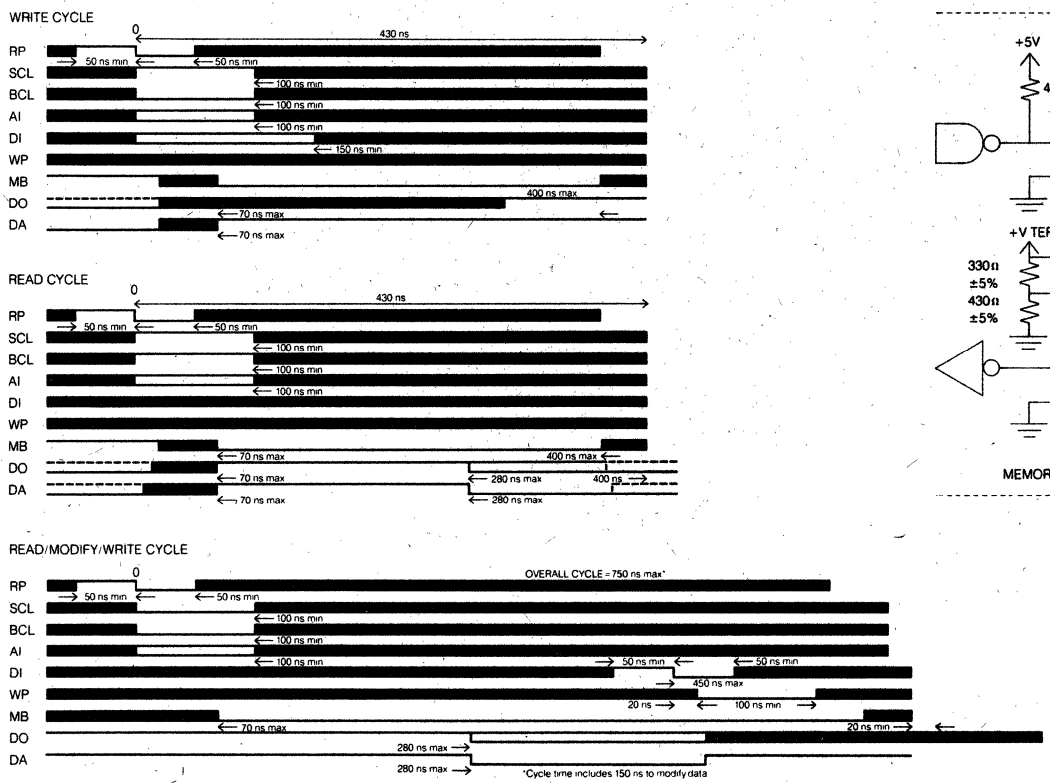
Environment
Operating: 0°C to +50°C
Non-operating: −40°C to 80°C
Humidity: 90% without condensation

Mechanical
Card Size: 11.75" x 15.40"
Connectors: 2 ea. 80 pin edge connectors with pins space "125" center to center

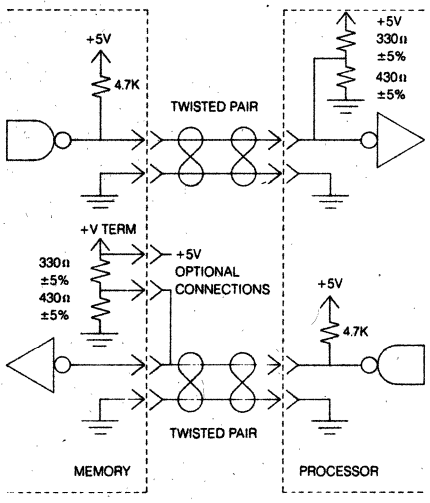
Power Requirements
Standard +15 −15V +5V
Option +12V −5V +5V

Standard Features
1 Byte mode
2 Late Data In—enables late presentation of data for write operation

Timing Diagrams



Typical Memory Card Interface



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NATIONAL SEMICONDUCTOR

NS3000-1 MEMORY CARD 16K x 20 BITS

- > Low cost
- > High Speed
- > Proven Reliability
- > Low Power
- > Special Options
- > Designed to incorporate special customer requirements
- > Bi-directional data transmission if required
- > TTL Compatible

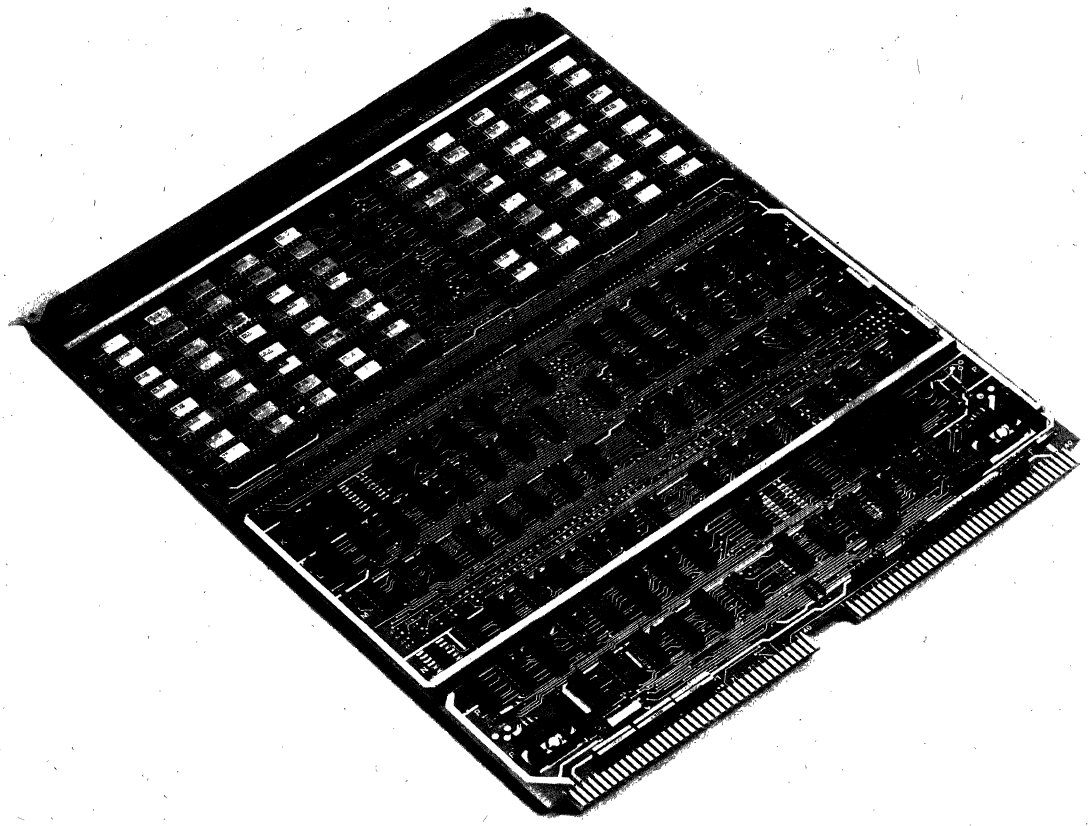
The NS3000 is a random access semiconductor memory contained on a single printed circuit card.

Design flexibility permits customized applications.

Standard configurations are 16K x 16, 18 or 20 bits with individual 8, 9, or 10 bit byte structure as an option.

Options include parity generation, parity check, late data input and data available reset.

It is designed for a wide range of applications including mainframe computers, mini-computers, microprocessor based systems, intelligent terminals and data entry.



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NS21 MEMORY STORAGE CARD 16K x 17 BITS

> 16K Double Density Storage Card for Hewlett Packard NS21 computer series.

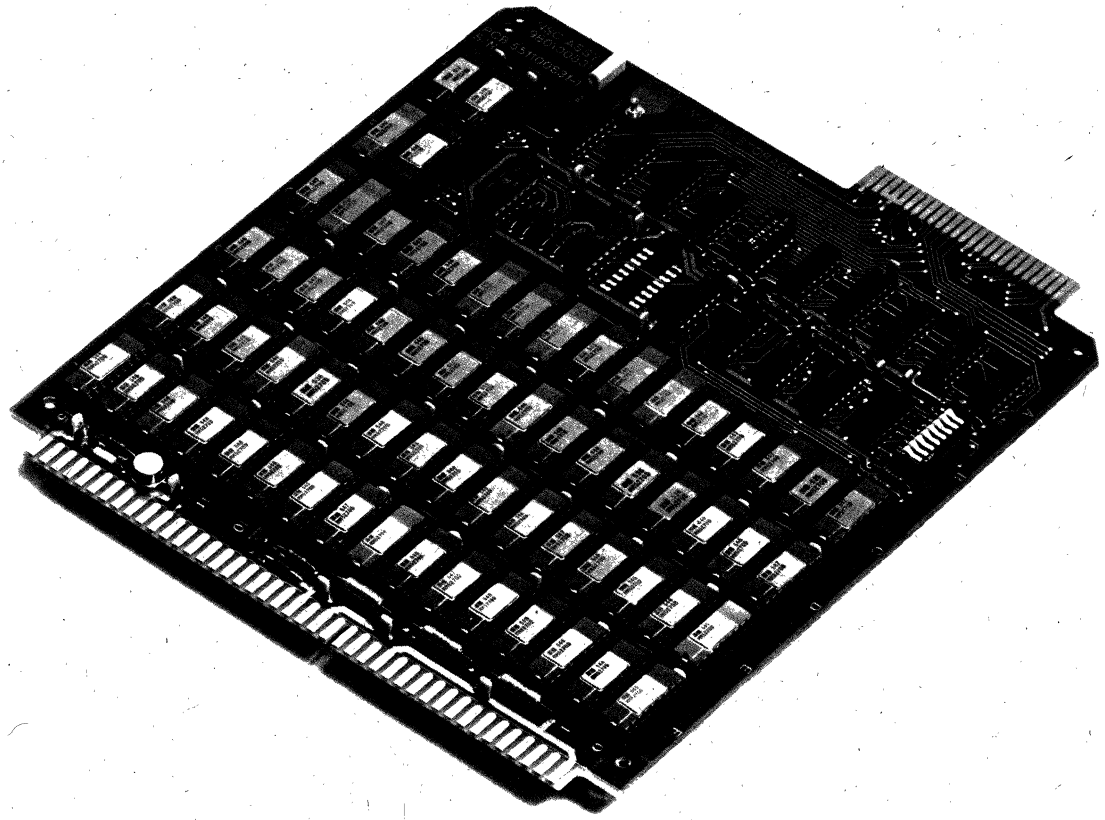
The National NS21 memory storage card is designed as an "add in" memory for use with the Hewlett Packard 2105, 2108 family of computers.

The memory size is 16K words and is available in a depopulated version of 8K words.

The card is used in conjunction with the NS21 control card which is built by National as NS21 Control Card. One control card can communicate with up to 12 storage cards for a maximum size of 192K words.

The address location in 16K blocks is selected on card by a dip switch. This enables the block address to be easily set or changed.

The 4K Dynamic RAM chip is used as the basic storage element which provides low cost and high reliability.



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NS11 MEMORY STORAGE CARD 16K x 16 BITS

Memory Card Capacity
16K words x 16 bits; depopulated memories 8K x 16 bits

Cycle Timing
Read (16 bits) 800 ns min.
Write (8 or 16 bits) 800 ns min.
Refresh (Burst mode repeated every 2 ms) 800 ns min.
Read/Modify/Write 1100 ns min.

Interface
All Address/Data & Control fully compatible with D.E.C. LSI-11 and PDP-11/03.

Power Requirements
Maximum operating current +5V @ 1.1A; +12V @ 0.5A
Refresh current +5V @ 1.1A; 12V @ 60 mA

Dimensions
8.9" × 10.44"

Maximum Component Height
.340 inches

Environmental (Operating)
Temperature 5°C to 50°C
Humidity 10% to 90% relative; non-condensing
Altitude To 8000 Ft. MSL

Environmental (Non-operating)
Temperature −20°C to +60°C
Humidity 10% to 90% Relative; without condensation
Altitude To 40,000 Ft MSL

Memory Card Interface Signals*

Signal	Mnemonic	Description/Function
Data/Address	BDAL 0 through BDAL 15	Time-shared bi-directional data and address lines; open collectors. Address bits are asserted by computer at beginning of memory cycle; data are asserted by computer or memory at end of memory cycle. BDAL 0: Selects Byte during address for Write cycles. Low: Write Byte 2 (bits 8-15) High: Write Byte 1 (bits 0-7) DATA LSB BDAL 13 through 15: Card Address Bits BDAL 15: DATA MSB
Refresh	BREF	From computer; initiates dynamic memory Refresh cycle.
Sync	BSYNC	From computer; leading edge initiates all memory cycles; remains low for entire cycle. Address data are stable 75 ns prior to sync.
Write Byte	BWTBT	From computer; down at fall of BSYNC initiates Write or Read/Modify/Write cycle. Down during BDOUT signals Write Byte (8 bits).
Data In	BDIN	From computer; when low, computer requests Read cycle.
Data Out	BDOUT	From computer; when low, computer requests Write or Write Byte cycle.
Reply	BRPLY	From memory; acknowledges BSYNC; signals data are available; signals end of memory cycle.
Power Up	BDCOK	From computer; indicates power is on. Must be high or memory will not cycle.

*All signals Active Low except BDCOK.

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NS11 MEMORY STORAGE CARD 16K x 16 BITS

- > 16K Double Density storage card
- > Fully Compatible with LSI-11, and PDP-11/03
- > High Speed
- > Low Cost

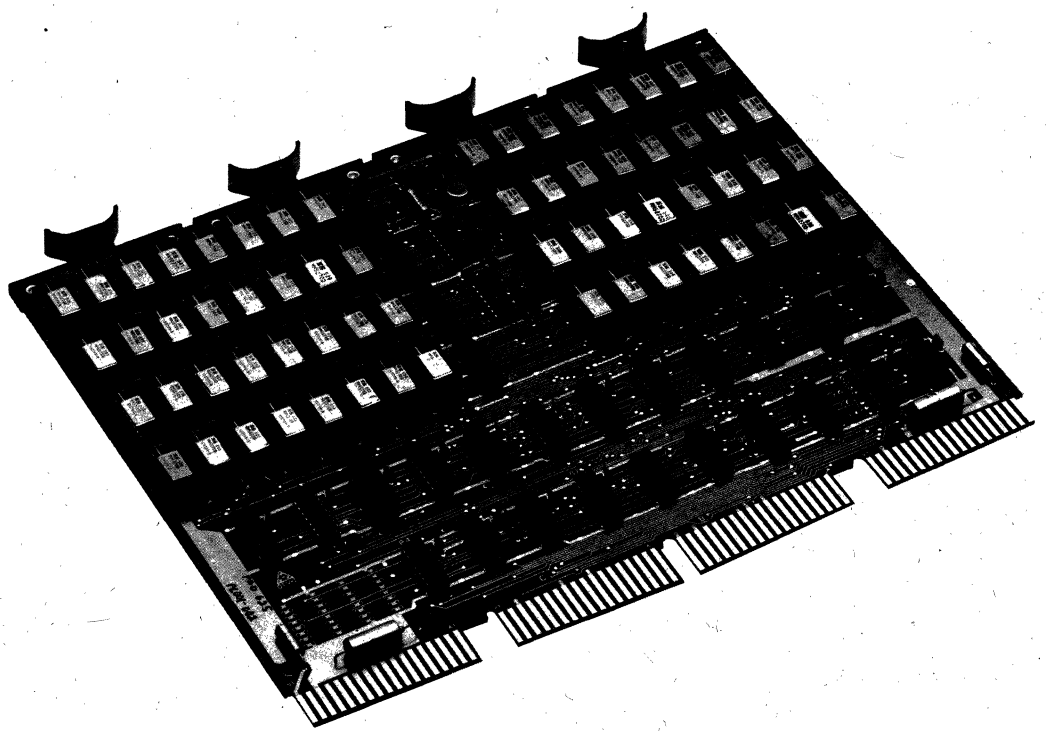
The National NS-11 is a 16K by 16 bit dynamic NMOS random access memory that is specifically designed for use with the Digital Equipment Corp. LSI-11* and PDP-11/03* processors. The LSI-11 memory card fits in LSI-11 and PDP-11/03 backplane assemblies, and is electrically compatible with the LSI-11 bus.

The key to the compact "double-density" design is the reliable National MM5270 4K dynamic 18 pin RAM which means a 40% increase in packing density. Consequently, the new 16K National card replaces four of the 4K RAM cards in the LSI-11 and PDP-11/03. One control circuit replaces four, saving both space and power, and increasing memory system reliability.

A depopulated (8K) version is also available. When used with the 16K version, the two cards provide 24K of memory, and it complements the resident 4K RAM on the LSI-11 processor. Since another 4K of address capacity is normally reserved for I/O, a 24K National memory system results in full utilization of the entire 32K address capacity in the LSI-11. At the same time, there is a net decrease in cost, space and power consumption.

Each NLSI-11 card contains independent card select, timing and control circuits. Addresses are jumper selected from 0 to 32K, in 4K increments, for full compatibility with the LSI-11 processor.

*Trademark of Digital Equipment Corp.



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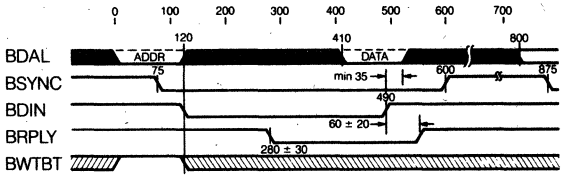
NLSI-11 Pin Assignments (View from Back Panel Side)

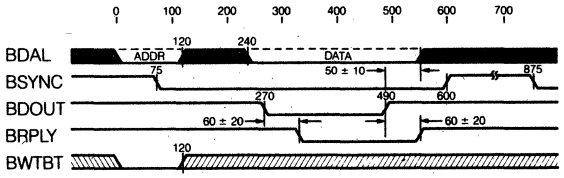
A A1	Spare	A A2	V_{CC}	B A1	BDCOK	B A2	V_{CC}
A B1		A B2	—	B B1	—	B B2	—
A C1		A C2	GND	B C1	Spare	B C2	GND
A D1		A D2	V_{DD}	B D1		B D2	—
A E1		A E2	BDOUT	B E1		B E2	BDAL2
A F1		A F2	BRPLY	B F1		B F2	BDAL3
A H1	Spare	A H2	BDIN	B H1	Spare	B H2	BDAL4
A J1	GND	A J2	BSYNC	B J1	GND	B J2	BDAL5
A K1	Jumper	A K2	BWTBT	B K1	V_{BB} Jumper	B K2	BDAL6
A L1	Jumper	A L2	—	B L1	V_{BB} Jumper	B L2	BDAL 7
A M1	GND	A M2	—	B M1	GND	B M2	BDAL8
A N1	—	A N2	—	B N1	Spare	B N2	BDAL9
A P1	—	A P2	—	B P1	Spare	B P2	BDAL10
A R1	BREF	A R2	—	B R1	—	B R2	BDAL11
A S1	Spare	A S2	—	B S1	Spare	B S2	BDAL12
A T1	GND	A T2	—	B T1	GND	B T2	BDAL13
A U1	Spare	A U2	BDAL0	B U1	Spare	B U2	BDAL14
A V1	—	A V2	BDAL1	B V1	V_{CC}	B U2	BDAL15

Timing Diagrams

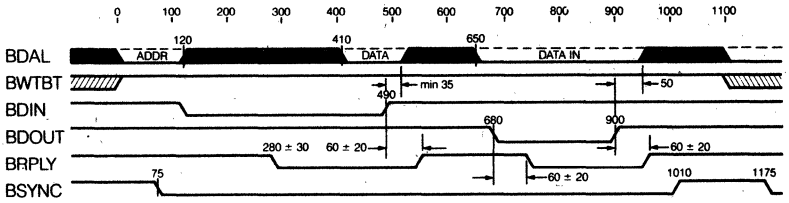
READ CYCLE: CYCLE TIME 800 NS MINIMUM



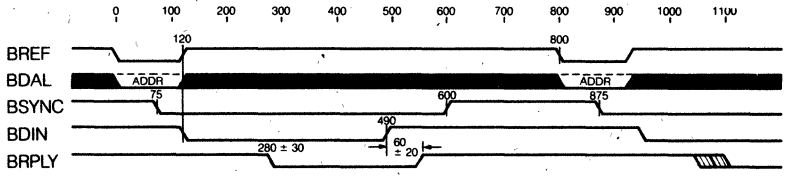
WRITE CYCLE; CYCLE TIME 800 NS MINIMUM



READ/MODIFY/WRITE CYCLE; CYCLE TIME 1100 NS MINIMUM



REFRESH CYCLE; CYCLE TIME 800 NS MINIMUM



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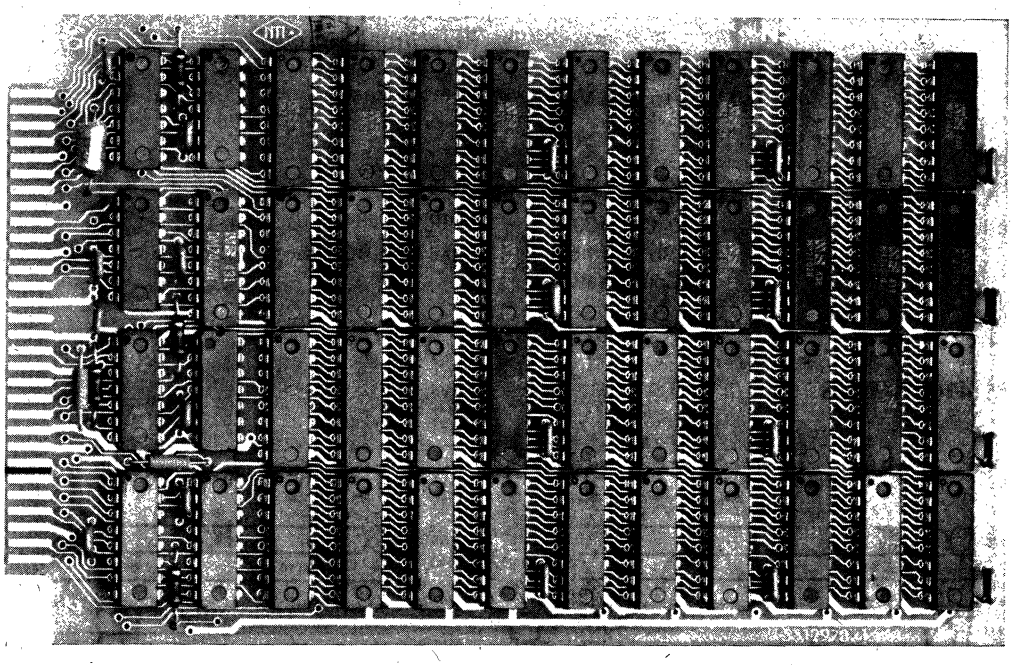
MOSRAM 410 memory system 4096 words X 10 bits



GENERAL DESCRIPTION

The MOSRAM 410 is designed to offer the systems engineer an alternative to the high cost design-prototype-test cycle. This memory system utilizes the MM2102 N-channel, 1k part as the storage medium. These static storage cells eliminate the need for clocks and refresh. Data in and data out have the same polarity and the read operation is nondestructive.

The simple interface and high performance make the MOSRAM 410 ideally suited for those memory applications, both large and small, where systems cost is an important consideration.

The only interface signals required are data in, data out, address, memory enable, and $\overline{R}/W$, all TTL compatible.

FEATURES

- Single +5.0V supply
- All inputs and outputs are DTL/TTL compatible
- Static operation—no clocks or refreshing required
- Low power 5W typ
- High speed 550 ns
- TRI-STATE® output for bus interface
- Programmable card select allows simple memory expansion to 32k x 10
- Small size 3.93 x 6.3 x 0.5 for 4k x 10
- Flexibility of speeds and capacities

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MOSRAM 410 MEMORY SYSTEM 4096 words X 10 bits

TECHNICAL SPECIFICATIONS

Performance

Cycle/Access Time: 550 ns

Modes of Operation

Read
Write

Power Requirements

+5 V_{DC} at 1.0A

Interface

Logic "1"	+2.4 V_{DC} to +5.5 V_{DC}
Logic "0"	
Input	0.0 V_{DC} to +0.6 V_{DC}
Output	0.0 V_{DC} to +0.4 V_{DC}

Environment

Operating	0°C to +50°C
Non-Operating	−40°C to +80°C
Humidity	To 90% Without Condensation

Mechanical

Memory Module	3.93" x 6.3"*
Mounting	0.5" Centers
Connector	60 Pin Card Edge Type 0.100 Centers (ELCO 00-6307-060-309-001)

Input Signals

Data In, 10 Bits	10 Lines
Address 15 Bits A0–A14	15 Lines
$\overline{\text{Read}}$/Write Control	1 Line
External Output Enable	1 Line
Memory Enable	1 Line

Output Signals

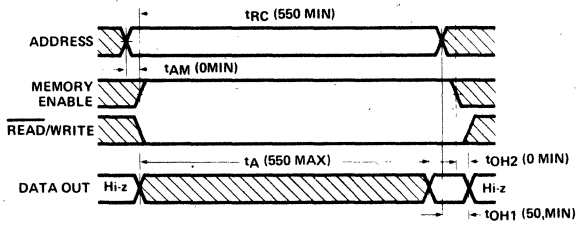
Data Out, 10 Bits	10 Lines

Memory Configuration Available as Follows:

4k x 10	Model 410
4k x 9	Model 409
4k x 8	Model 408
2k x 10	Model 210
2k x 9	Model 209
2k x 8	Model 208

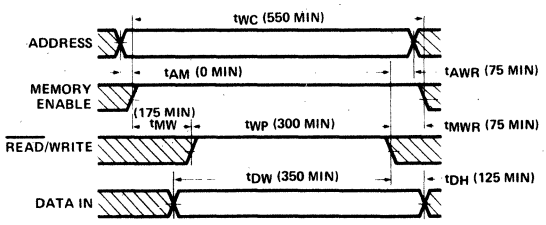
MOSRAM 410 TIMING

Read Cycle



t_{RC} (min)	550 ns
t_{AM} (min)	0
t_A (max)	550
t_{OH2} (min)	0
t_{OH1} (min)	50

Write Cycle



t_{WC} (min)	550 ns
t_{AM} (min)	0
t_{AWR} (min)	75
t_{MW} (min)	175
t_{WP} (min)	300
t_{MWR} (min)	75
t_{DW} (min)	350
t_{DH} (min)	125

*Eurocard has 64 pin, on 0.100 centers connector.

All National memory systems must meet stringent quality and test standards prior to shipment. Memory components are burned in, and systems undergo an extensive diagnostic test prior to shipment.

Manufactured under one or more of the following U.S. patents: 3083262, 3189758, 3231797, 3303356, 3317671, 3323071, 3381071, 3408542, 3421025, 3426423, 3440498, 3518750, 3519897, 3557431, 3560765, 3566218, 3571630, 3575609, 3579059, 3593069, 3597640, 3607469, 3617859, 3631312, 3633052, 3638131, 3648071, 3651565, 3693248.

National Semiconductor Corporation
2900 Semiconductor Drive, Santa Clara, California 95051, (408) 737-5000/TWX (910) 339-9240
National Semiconductor GmbH
808 Fuerstenfeldbruck, Industriestrasse 10, West Germany, Tele. (08141) 1371/Telex 05-27649
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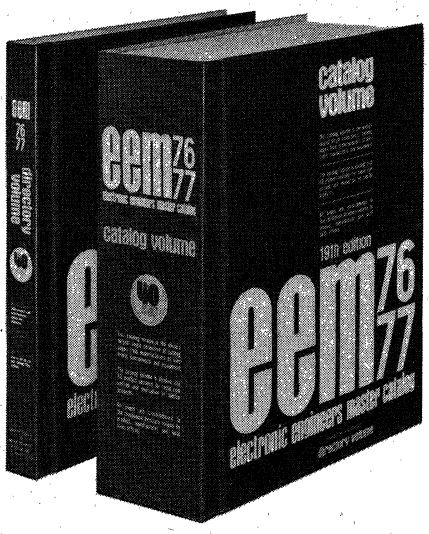

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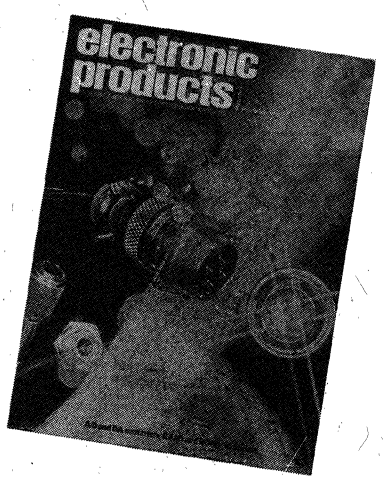

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Patti Foley
UNITED TECHNICAL PUBLICATIONS, INC.
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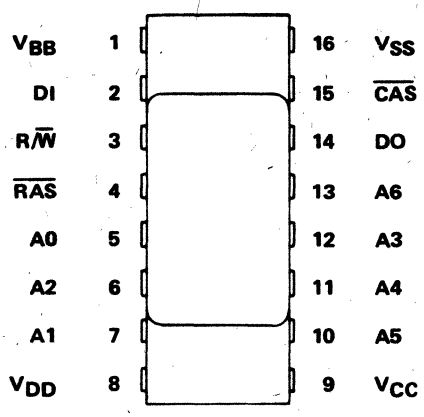
TMS4070JL, TMS4070-1JL, TMS4070-2JL
16,384-bit Dynamic Random-Access Memory

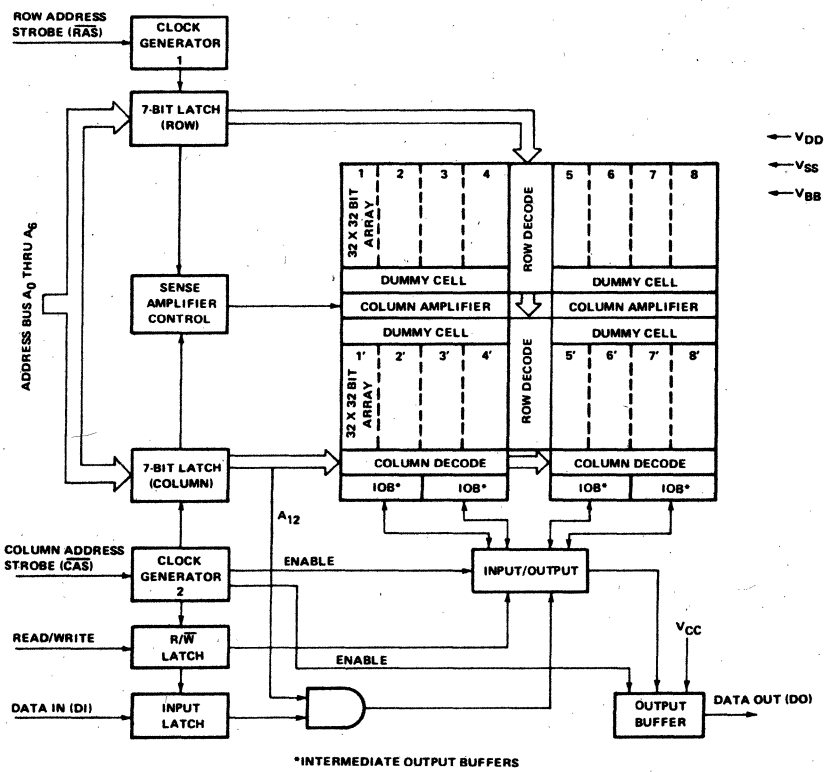
16-PIN CERAMIC
DUAL-IN-LINE PACKAGE
(TOP VIEW)



- 16,384 × 1 organization
- 16-pin 300-mil package configuration
- All inputs including clocks TTL compatible
- Three-state fully TTL-compatible output
- On-chip latches for addresses and data input
- 3 performance ranges:

	ACCESS TIME ROW ADDRESS (MAX)	ACCESS TIME COLUMN ADDRESS (MAX)	READ OR WRITE CYCLE (MIN)	READ-MODIFY WRITE CYCLE (MIN)
TMS 4070	350 ns	255 ns	500 ns	730 ns
TMS 4070-1	300 ns	210 ns	450 ns	660 ns
TMS 4070-2	250 ns	165 ns	400 ns	590 ns

- Page-mode operation for faster access time
- Common I/O capability
- Low-power dissipation
  - less than 600 mW operating (typical)
  - 10 mW standby (typical)
- 1-T cell design, N-channel silicon-gate technology



TEXAS INSTRUMENTS
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electrical characteristics over full ranges of recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT
V_{OH}	High-level output voltage	I_{OH} = −5 mA	2.4			V
V_{OL}	Low-level output voltage	I_{OL} = 4 mA, C_L = 50 pF			0.4	V
I_I	Input current (leakage)	V_I = 0 V to 6 V, All other pins = 0 V except V_{BB} = −5 V			10	μA
I_O	Output current (leakage)	V_O = 0 V to 7 V, $\overline{RAS}$ and $\overline{CAS}$ high			10	μA
$I_{CC(av)}$*	Average supply current from V_{CC}	2 Series 74 TTL worst case loads		1.5	4	mA
$I_{DD(av)}$	Supply current from V_{DD}, $\overline{RAS}$ only	$\overline{RAS}$ low, $\overline{CAS}$ high		30	40	mA
I_{DD}	Supply current from V_{DD}, Standby	$\overline{RAS}$ and $\overline{CAS}$ high (after 1 memory cycle)		0.8	1.5	mA
$I_{DD(av)}$	Average supply current from V_{DD} during read or write cycle	Minimum cycle time		48	70	mA
$I_{DD(av)}$	Average supply current from V_{DD} during read-modify write cycle	Minimum cycle time		54	76	mA
$I_{BB(av)}$	Average supply current from V_{BB}	Minimum cycle time		40	100	μA

*V_{CC} is applied only to the output buffer, so I_{CC} depends on output loading.

capacitance over recommended supply volrage range and operating free-air temperature range f = 1 MHz

PARAMETER		TYP†	MAX	UNIT
$C_{i(ad)}$	Input capacitance, address inputs	6	9	pF
$C_{i(RAS,CAS)}$	Input capacitance, strobe inputs	6	9	pF
$C_{i(data)}$	Input capacitance, data input	6	9	pF
$C_{i(w)}$	Input capacitance, read/write input	6	9	pF
C_o	Output capacitance	6	9	pF

†All typical values are at T_A = 25°C and nominal supply voltages.

switching characteristics over recommended supply voltage range and operating free-air temperature range

PARAMETER		TEST CONDITIONS	TMS 4070		TMS 4070-1		TMS 4070-2		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
$t_{a(CAS)}$	Access time from column address strobe	C_L = 50 pF, $t_{r(CAS)}$ and $t_{r(RAS)}$ = 5 ns, $t_{RASL,CASL}$ = MAX, Load = 2 Series 74 TTL gates		255		210		165	ns
$t_{a(RAS)}$	Access time from row address strobe			350		300		250	ns
t_{PZX}	Output enable time	C_L = 50 pF, Load = 2 Series 74 TTL gates		150		150		150	ns
t_{PXZ}	Output disable time		10	100	10	100	10	100	ns

NOTE: A.C. characteristics guaranteed only for cumulative $\overline{RAS}$ duty cycle less than 65% over each 2 ms period.

recommended operating conditions

PARAMETER	MIN	NOM	MAX	UNIT
Supply voltage, V_{BB}	−4.5	−5	−5.5	V
Supply voltage, V_{CC}	4.5	5	5.5	V
Supply voltage, V_{DD}	11.4	12	12.6	V
Supply voltage, V_{SS}		0		V
High-level input voltage, V_{IH}	2.4		5.5	V
Low-level input voltage, V_{IL}	−1.0		0.8	V
Refresh time, $t_{refresh}$			2	ms
Operating free-air temperature, T_A	0		70	°C

Is Your Memory Design Static?

Make Your Designs Dynamic. Texas Instruments TTL Compatible 4K RAMs Make It Easy...

HERE'S WHY DYNAMIC DESIGNERS USE TI 4K RAMs.

☑ 36% Less Operating Power

Compare 1K low-power static RAMs with TI's TMS 4051 4K dynamic RAM. The table refers to maximum—not typical—values to provide a realistic comparison.

☑ 40% Less Standby Power

Low standby power is inherent in the 4K dynamic RAM operation—while static RAMs require extra circuitry to reduce V_{CC} to a low level.

☑ Fully TTL Compatible

The TMS 4051 inputs and output (including clock) interface directly with TTL.

☑ Fast Access Time

TI's 4K dynamic RAMs are fast. The TMS 4051-1 (with TTL clock) has a maximum access time of 250 ns, the same as the 2102AL-2.

Parameter	Four 1K Static RAMs (2102 AL-2)	One 4K Dynamic RAM (TMS 4051-1)
Power (max.) operating	1368 mW	882 mW
standby	168 mW	101 mW
Access (max.)	250 ns	250 ns
Board area ratio	3.6	1.0
Fully TTL compatible	yes	yes
100 Pc prices	$20.00	$12.26

Based on published data

☑ 80% Less Board Area

You get almost four times the memory density by switching to TI 18-pin 4K RAMs. The reason? TI's compact 18-pin 300-mil-wide package—available in either plastic or ceramic.

☑ Lower Cost

TI's 4K dynamic RAM offers significant system cost savings even when including the additional simple circuitry for refresh.

☑ Simple Refresh

It's easy! Just 4-8 TTL packages per memory system are typically needed. To see how easy refresh can be, send for our Application Note.

☑ Easy to Use

TI's 18-pin 4K RAMs feature simple 12-line non-multiplexed address and a single non-critical clock. Data input and output are multiplexed—ideal for use with microprocessor-based systems.

☑ Applications Help

For your copy of the 4K dynamic RAM Application Note covering simple refresh, contact: Texas Instruments, M/S 669-4K, P.O. Box 1443, Houston, Texas 77001.

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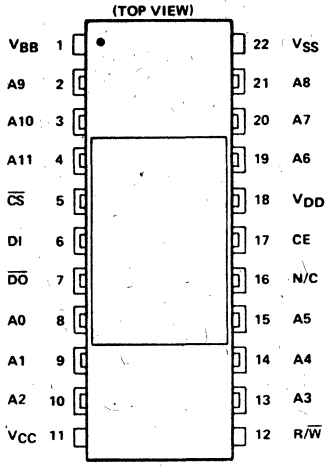
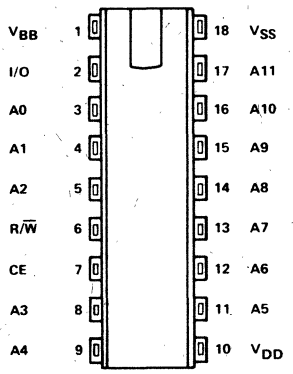
4096-bit MOS Dynamic Random-Access Memories

22-PIN CERAMIC AND PLASTIC DUAL-IN-LINE PACKAGES (TOP VIEW)



TMS 4030
TMS 4060

18-PIN CERAMIC AND PLASTIC DUAL-IN-LINE PACKAGES (TOP VIEW)



TMS 4050
TMS 4051

- 4096 × 1 organization
- Full TTL compatibility
- Registers for addresses provided on chip
- Single simple clock
- Low power dissipation
- N-channel silicon-gate technology

Description

The TMS 4030, 4050, 4051, and 4060 series are composed of high-speed dynamic 4096-bit MOS random-access memories, organized as 4096 one-bit words. Reliable N-channel silicon-gate technology is employed to optimize the speed/power/density trade-off. Several performance options are offered to allow the system designer to match the memory performance to the capability of the arithmetic processor.

On the 4030, 4050, and 4060, all inputs except the chip enable are fully TTL compatible and require no pull-up resistors. The 4051 has a TTL-compatible CE also. The input buffers allow a minimum 200 mV noise margin when driven by a Series 74 TTL device. All output buffers are TTL compatible. A direct 12-line address is latched on chip minimizing external control logic. Device types are available in the 0° to 70° C industrial or −55° to 85° C extended temperature range. Hi-rel versions (prefix SMC) processed to class B of MIL-STD-883/Level III of TI 38510/MACH IV program.

	Typical Power Dissipation (mW)		
DEVICE	ACTIVE	STBY	TO RETAIN DATA
4030	400	0.2	6
4050	420	0.1	6
4051	460	60	70
4060	400	0.3	6

DEVICE	PKG	ACCESS	READ/WRITE CYCLE	CLOCK	SUPPLY VOLTAGES	OUTPUT SERIES 74 TTL GATE FAN-OUT
TMS 4030	22 pin	300 ns	470 ns	Hi-level	−3, +5, +12	2
TMS 4030-1	22 pin	250 ns	430 ns	Hi-level	−3, +5, +12	2
TMS 4030-2	22 pin	200 ns	400 ns	Hi-level	−3, +5, +12	2
TMS 4050	18 pin	300 ns	470 ns	Hi-level	−5, +12	1 open-drain
TMS 4050-1	18 pin	250 ns	430 ns	Hi-level	−5, +12	1 open-drain
TMS 4050-2	18 pin	200 ns	400 ns	Hi-level	−5, +12	1 open-drain
TMS 4051	18 pin	300 ns	470 ns	TTL	−5, +12	1 open-drain
TMS 4051-1	18 pin	250 ns	430 ns	TTL	−5, +12	1 open-drain
TMS 4060	22 pin	300 ns	470 ns	Hi-level	±5, +12	2
TMS 4060-1	22 pin	250 ns	430 ns	Hi-level	±5, +12	2
TMS 4060-2	22 pin	200 ns	400 ns	Hi-level	±5, +12	2
TMS 4060-3	22 pin	150 ns	380 ns	Hi-level	±5, +12	2

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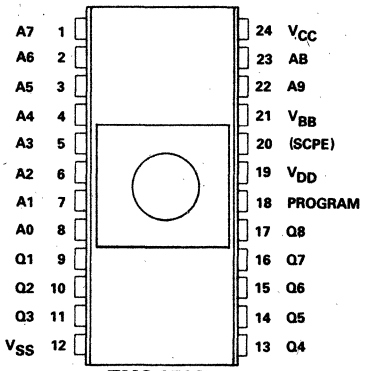
TMS2708, TMS4700, TMS4732
8K EPROM, 8K ROM, 32K ROM

- All inputs and outputs TTL compatible
- Static operation (no clocks, no refresh)
- 3-state outputs for OR-ties
- Maximum access time...450 ns
- Minimum cycle time...450 ns
- N-channel silicon-gate technology
- 8-bit output for use in microprocessor based systems

24-PIN CERAMIC
DUAL-IN-LINE PACKAGE
(TOP VIEW)

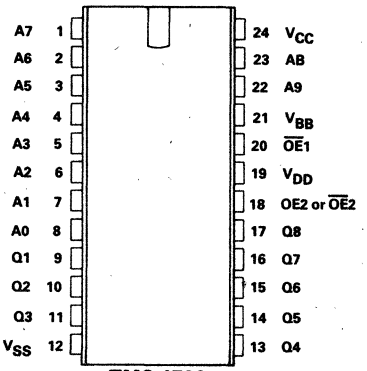


TMS 2708
8K EPROM

TMS 2708

- UV light erasable, electrically programmable ROM
- 1K × 8 organization
- Change pin 18 for TMS 4700 compatibility
- ±5V, +12V supplies
- Typical power dissipation 450 mW

24-PIN CERAMIC AND PLASTIC
DUAL-IN-LINE PACKAGES
(TOP VIEW)

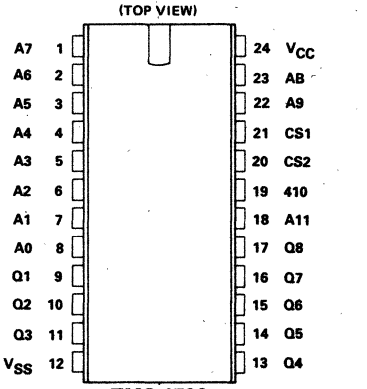


TMS 4700
8K ROM

TMS 4700

- Mask programmable ROM
- 1K × 8 organization
- Compatible with TMS 2708
- ±5V, +12V supplies
- Typical power dissipation 310 mW

24-PIN CERAMIC AND PLASTIC
DUAL-IN-LINE PACKAGES
(TOP VIEW)



TMS 4732
32K ROM

TMS 4732

- Mask programmable ROM
- 4K × 8 organization
- Upward compatible with TMS 4700 and TMS 2708
- Single +5V supply
- Two chip select controls
- Typical power dissipation 325 mW
- Available in 1977

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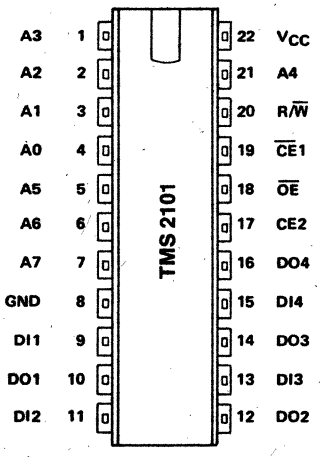
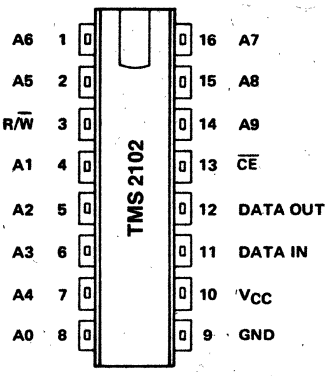
TMS2101, TMS2102, TMS2111, TMS2112, TMS4036 Static Random-Access Memories

22-PIN CERAMIC AND PLASTIC DUAL-IN-LINE PACKAGES (TOP VIEW)



16-PIN CERAMIC AND PLASTIC DUAL-IN-LINE PACKAGES (TOP VIEW)



All TI Static RAM's are easy to use:

- No clocks—no refresh
- I/O fully TTL compatible
- 3-state output for OR-tie capability
- Single +5V supply
- Simple, fully decoded addressing

TI Static RAM's feature:

- Reliability, same process as TI's industry standard 4K RAM's
- Economy, high volume production techniques and choice of plastic or ceramic packaging
- Extremely low standby power (typically 2-3 mW) due to TI's enhancement mode design
- Complete range of speeds for design optimization
- Easy to use 8-bit byte organization (64 x 8) along with industry-standard 256 x 4 and 1024 x 1 organizations

DEVICE	ORGANIZATION	MAX. ACCESS/ MIN. CYCLE	TYPICAL POWER DISS.	PACKAGE TYPE	PACKAGE PINS
TMS 2101 /4039	256 × 4	1000 ns	175 mW	CDIP/Plas	22
TMS 2101-2/4039-1	256 × 4	650 ns	175 mW	CDIP/Plas	22
TMS 2101-1/4039-2	256 × 4	450 ns	175 mW	CDIP/Plas	22
TMS 2102-1/4033	1024 × 1	450 ns	225 mW	CDIP/Plas	16
TMS 2102-2/4034	1024 × 1	650 ns	225 mW	CDIP/Plas	16
TMS 2102 /4035	1024 × 1	1000 ns	225 mW	CDIP/Plas	16
TMS 2111 /4042	256 × 4	1000 ns	175 mW	CDIP/Plas	18
TMS 2111-2/4042-1	256 × 4	650 ns	175 mW	CDIP/Plas	18
TMS 2111-1/4042-2	256 × 4	450 ns	175 mW	CDIP/Plas	18
TMS 2112 /4043	256 × 4	1000 ns	175 mW	CDIP/Plas	16
TMS 2112-2/4043-1	256 × 4	650 ns	175 mW	CDIP/Plas	16
TMS 4043-2	256 × 4	450 ns	175 mW	CDIP/Plas	16
TMS 4036	64 × 8	1000 ns	250 mW	Plas	20
TMS 4036-1	64 × 8	650 ns	250 mW	Plas	20
TMS 4036-2	64 × 8	450 ns	250 mW	Plas	20
*TMS 4044	4096 × 1	200 ns	450 mW	CDIP/Plas	18
*TMS 4045	1024 × 4	200 ns	450 mW	CDIP/Plas	18

*Available in 1977

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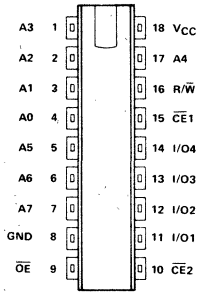
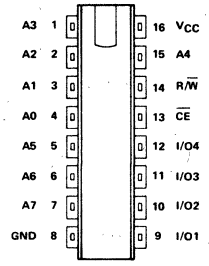
TMS4044, TMS4045 4096-bit Static Random-Access Memories

18-PIN CERAMIC AND PLASTIC DUAL-IN-LINE PACKAGES (TOP VIEW)



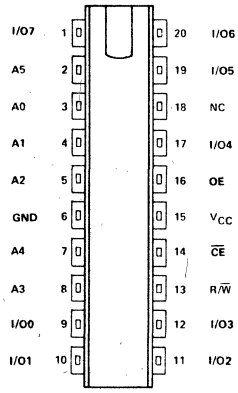
TMS 4042

16-PIN CERAMIC AND PLASTIC DUAL-IN-LINE PACKAGES (TOP VIEW)



TMS 4043

20-PIN CERAMIC AND PLASTIC DUAL-IN-LINE PACKAGES (TOP VIEW)



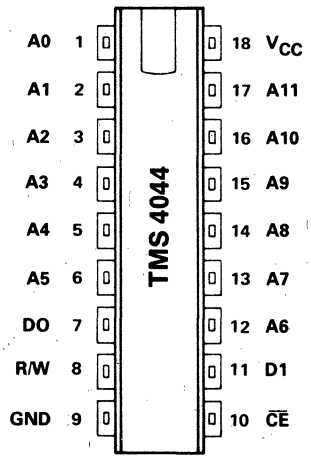
TMS 4036

TI Static RAM Benefits

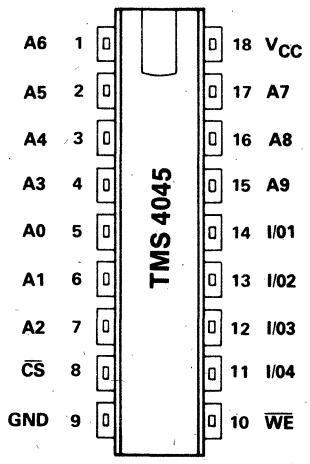
- Reduced overhead costs since refresh-clocking circuitry is eliminated
- Low cost, high performance due to N-channel silicon-gate technology
- Cost/performance trade-off maximized by multiple speed availability

New from TI!* 4K Static RAMs

18-PIN CERAMIC AND PLASTIC DUAL-IN-LINE PACKAGES (TOP VIEW)



18-PIN CERAMIC AND PLASTIC DUAL-IN-LINE PACKAGES (TOP VIEW)



TMS 4044	4096 × 1	STATIC RAM
TMS 4045	1024 × 4	STATIC RAM

COMMON FEATURES

- Single +5V supply voltage
- Fully static operation; no clocks required
- All inputs and outputs TTL compatible — no pull-up resistors required
- 18-pin dual-in-line packages
- Access time/cycle time 200 ns.
- Power dissipation 450 mW

*Available 1977. All specifications are tentative.

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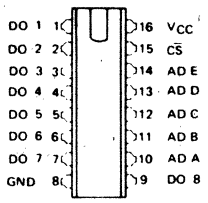
SERIES 54S/74S PROGRAMMABLE READ-ONLY MEMORIES

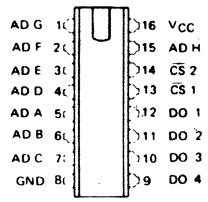
- Titanium-Tungsten (Ti-W) Fuse Links for Fast, Low-Voltage, Reliable Programming
- All Schottky-Clamped PROM's Offer:
  - Fast Chip Select to Simplify System Decode
  - Choice of Three-State or Open-Collector Outputs
  - P-N-P Inputs for Reduced Loading on System Buffers/Drivers
- Full Decoding and Chip Select Simplify System Design
- Applications Include:
  - Microprogramming/Firmware Loaders
  - Code Converters/Character Generators
  - Translators/Emulators
  - Address Mapping/Look-Up Tables

TYPE NUMBER (PACKAGES)		BIT SIZE (ORGANIZATION)	OUTPUT CONFIGURATION	TYPICAL PERFORMANCE	
–55°C to 125°C	0°C to 70°C			ADDRESS ACCESS TIME	POWER DISSIPATION
SN54S188(J, W)	SN74S188(J, N)	256 bits (32 W x 8 B)	open-collector	25 ns	400 mW
SN54S288(J, W)	SN74S288(J, N)		three-state		
SN54S287(J, W)	SN74S287(J, N)	1024 bits (256 W x 4 B)	three-state	42 ns	500 mW
SN54S387(J, W)	SN74S387(J, N)		open-collector		
SN54S470(J)	SN74S470(J, N)	2048 bits (256 W x 8 B)	open-collector	50 ns	550 mW
SN54S471(J)	SN74S471(J, N)		three-state		
SN54S472(J)	SN74S472(J, N)	4096 bits (512 W x 8 B)	three-state	55 ns	600 mW
SN54S473(J)	SN74S473(J, N)		open-collector		
SN54S474(J, W)	SN74S474(J, N)	4096 bits (512 W x 8 B)	three-state	55 ns	600 mW
SN54S475(J, W)	SN74S475(J, N)		open-collector		

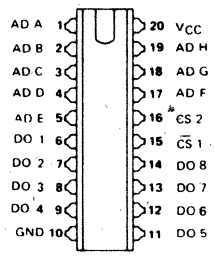
256 BITS (32 WORDS BY 8 BITS) 'S188, 'S288



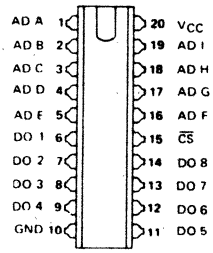
1024 BITS (256 WORDS BY 4 BITS) 'S287, 'S387



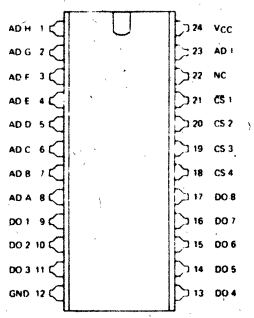
2048 BITS (256 WORDS BY 8 BITS) 'S470, 'S471



4096 BITS (512 WORDS BY 8 BITS) 'S472, 'S473



4096 BITS (512 WORDS BY 8 BITS) 'S474, 'S475



Pin assignments for all of these memories are the same for all packages.

description

These monolithic TTL programmable read-only memories (PROM's) feature titanium-tungsten (Ti-W) fuse links with each link designed to program in one millisecond or less. These PROM's offer considerable flexibility for upgrading existing designs or improving new designs as they feature full Schottky clamping for improved performance, low-current MOS-compatible p-n-p inputs, choice of bus-driving three-state or open-collector outputs, and improved chip-select access times.

The high-complexity 2048- and 4096-bit 20-pin PROM's can be used to significantly improve system density for fixed memories as all are offered in a dual-in-line package having pin-row spacings of 0.300 inch.

PRELIMINARY DATA SHEET: Supplementary data may be published at a later date.

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†Integrated Schottky-Barrier diode-clamped transistor is patented by Texas Instruments. U. S. Patent Number 3,463,975.

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description (continued)

Data can be electronically programmed, as desired, at any bit location in accordance with the programming procedure specified. All PROM's, except the 'S287 and 'S387, are supplied with a low-logic-level output condition stored at each bit location. The programming procedure open-circuits Ti-W metal links, which reverses the stored logic level at selected locations. The procedure is irreversible; once altered, the output for that bit location is permanently programmed. Outputs never having been altered may later be programmed to supply the opposite output level. Operation of the unit within the recommended operating conditions will not alter the memory content.

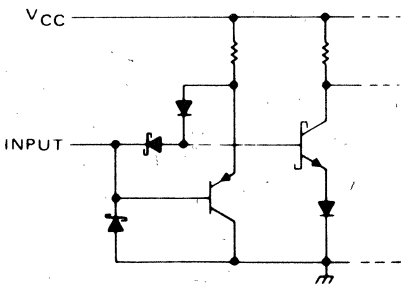
Active level(s) at the chip-select input(s) enables all of the outputs. An inactive level at any chip-select input causes all outputs to be off.

The three-state output offers the convenience of an open-collector output with the speed of a totem-pole output; it can be bus-connected to other similar outputs yet it retains the fast rise time characteristic of the TTL totem-pole output. The open-collector output offers the capability of direct interface with a data line having a passive pull-up.

schematics of inputs and outputs

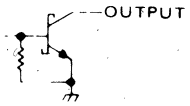
'S188, 'S287, 'S288, 'S387, 'S470, 'S471, 'S472, 'S473, 'S474, 'S475

EQUIVALENT OF EACH INPUT



'S188, 'S387, 'S470, 'S473, 'S475

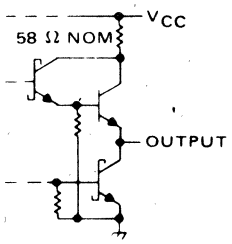
TYPICAL OF ALL OUTPUTS



Programming circuit not shown

'S287, 'S288, 'S471, 'S472, 'S474

TYPICAL OF ALL OUTPUTS



Programming circuit not shown

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage (see Note 1) . . . . . 7 V
Input voltage . . . . . 5.5 V
Off-state output voltage . . . . . 5.5 V
Operating free-air temperature range: SN54S' Circuits . . . . . −55°C to 125°C
SN74S' Circuits . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C

recommended conditions for programming

		SN54S', SN74S'			UNIT
		MIN	NOM	MAX	
Supply voltage, V_{CC} (see Note 1)	Steady state	4.75	5	5.75	V
	Program pulse	10	10.5	11†	
Input voltage	High level, V_{IH}	2.4		5	V
	Low level, V_{IL}	0		0.5	
Termination of all outputs except the one to be programmed		See load circuit (Figure 1)			
Voltage applied to output to be programmed, $V_{O(pr)}$ (see Note 2)		0	0.25	0.3	V
Duration of V_{CC} programming pulse Y (see Figure 2 and Note 3)		1		10	ms
Programming duty cycle			25	35	%
Free-air temperature		0		55	°C

†Absolute maximum ratings.

NOTES: 1. Voltage values are with respect to network ground terminal. The supply-voltage rating does not apply during programming.
2. The 'S188, 'S288, 'S470, 'S471, 'S472, 'S473, 'S474, and 'S475 are supplied with all bit locations containing a low logic level, and programming a bit changes the output of the bit to high logic level. The 'S287 and 'S387 are supplied with all bit outputs at a high logic level, and programming a bit changes it to a low logic level.
3. Programming is guaranteed if the pulse applied is 1 ms long.

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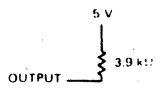
step-by-step programming procedure

1. Apply steady-state supply voltage (V_{CC} = 5 V) and address the word to be programmed.
2. Verify that the bit location needs to be programmed. If not, proceed to the next bit.
3. If the bit requires programming, disable the outputs by applying a high-logic-level voltage to the chip-select input(s).
4. Only one bit location is programmed at a time. Connect each output not being programmed to 5 V through 3.9 kΩ and apply the voltage specified in the table to the output to be programmed. Maximum current out of the programming output supply during programming is 150 mA.
5. Step V_{CC} to 10.5 V nominal. Maximum supply current required during programming is 750 mA.
6. Apply a low-logic-level voltage to the chip-select input(s). This should occur between 10 μs and 1 ms after V_{CC} has reached its 10.5-V level. See programming sequence of Figure 2.
7. After the X pulse time (1 ms) is reached, a high logic level is applied to the chip-select inputs to disable the outputs.
8. Within 10 μs to 1 ms after the chip-select input(s) reach a high logic level, V_{CC} should be stepped down to 5 V at which level verification can be accomplished.
9. The chip-select input(s) may be taken to a low logic level (to permit program verification) 10 μs or more after V_{CC} reaches its steady-state value of 5 V.
10. At a Y pulse duty cycle of 35% or less, repeat steps 1 through 8 for each output where it is desired to program a bit.

NOTE: Only one programming attempt per bit is recommended.



LOAD CIRCUIT FOR EACH OUTPUT NOT BEING PROGRAMMED OR FOR PROGRAM VERIFICATION
FIGURE 1

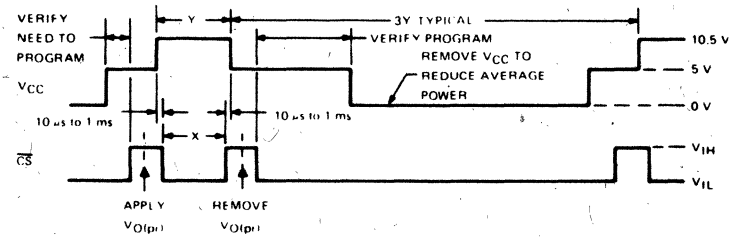


FIGURE 2–VOLTAGE WAVEFORMS FOR PROGRAMMING

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recommended operating conditions

		'S188			'S387, 'S470			'S473, 'S475			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	Series 54S	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
	Series 74S	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	
High-level output voltage, V_{OH}				5.5			5.5			5.5	V
Low-level output current, I_{OL}				20			16			12	mA
Operating free-air temperature, T_A	Series 54S	−55		125	−55		125♦	−55		125	°C
	Series 74S	0		70	0		70	0		70	

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS†		MIN	TYP‡	MAX	UNIT
V_{IH}	High-level input voltage			2			V
V_{IL}	Low-level input voltage					0.8	V
V_{IK}	Input clamp voltage	V_{CC} = MIN,	I_I = −18 mA			−1.2	V
I_{OH}	High-level output current	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V	V_{OH} = 2.4 V			50	μA
			V_{OH} = 5.5 V			100	
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IL} = 0.8 V,	V_{IH} = 2 V, I_{OL} = MAX			0.5	V
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 5.5 V			1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V			25	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.5 V			−250	μA
I_{CC}	Supply current	V_{CC} = MAX, Chip select(s) at 0 V, Outputs open, See Note 4	'S188		80	110	mA
			'S387		100	135	
			'S470		110	155	
			'S473; 'S475		120	155	

switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

TYPE	TEST CONDITIONS	$t_{a(ad)}$ (ns) Access time from address		$t_{a(\overline{CS})}$ (ns) Access time from chip select (enable time)		t_{PLH} (ns) Propagation delay time, low-to-high-level output from chip select (disable time)	
		TYP‡	MAX	TYP‡	MAX	TYP‡	MAX
SN54S188	C_L = 30 pF, R_{L1} = 300 Ω, R_{L2} = 600 Ω, See Figure 3	25	50	12	30	12	30
SN74S188		25	40	12	25	12	25
SN54S387		42	75	15	40	15	40
SN74S387		42	65	15	35	15	35
SN54S470		50	80	20	40	15	35
SN74S470		50	70	20	35	15	30
SN54S473, SN54S475		55	85	20	45	15	40
SN74S473, SN74S475		55	75	20	40	15	35

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
♦An SN54S387 in the W package operating at free-air temperatures above 108°C requires a heat sink that provides a thermal resistance from case-to-free-air, $R_{\theta CA}$, of not more than 42°C/W.
NOTE 4: The typical values of I_{CC} shown are with all outputs low.

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recommended operating conditions

		'S287, 'S471			'S288			'S472, 'S474			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	Series 54S	4.5	5	5.5	4.5	5	5.5	4.5	5	5.5	V
	Series 74S	4.75	5	5.25	4.75	5	5.25	4.75	5	5.25	
High-level output current, I_{OH}	Series 54S			−2			−2			−2	mA
	Series 74S			−6.5			−6.5			−6.5	
Low-level output current, I_{OL}				16			20			12	mA
Operating free-air temperature, T_A	Series 54S	−55		125♦	−55		125	−55		125	°C
	Series 74S	0		70	0		70	0		70	

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS†		SN54S'			SN74S'			UNIT
				MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage			2			2			V
V_{IL}	Low-level input voltage					0.8			0.8	V
V_{IK}	Input clamp voltage	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IL} = 0.8 V,	V_{IH} = 2 V, I_{OH} = MAX	2.4	3.4		2.4	3.2		V
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IL} = 0.8 V,	V_{IH} = 2 V, I_{OL} = MAX			0.5			0.5	V
I_{OZH}	Off-state output current, high-level voltage applied	V_{CC} = MAX, V_O = 2.4 V	V_{IH} = 2 V,			50			50	μA
I_{OZL}	Off-state output current, low-level voltage applied	V_{CC} = MAX, V_O = 0.5 V	V_{IH} = 2 V,			−50			−50	μA
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.5 V			−250			−250	μA
I_{OS}	Short-circuit output current§	V_{CC} = MAX		−30		−100	−30		−100	mA
I_{CC}	Supply current	V_{CC} = MAX, Chip select(s) at 0 V, Outputs open, See Note 4	'S287		100	135		100	135	mA
			'S288		80	110		80	110	
			'S471		110	155		110	155	
			'S472, 'S474		120	155		120	155	

switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

TYPE	TEST CONDITIONS	$t_{a(ad)}$ (ns) Access time from address		$t_{a(\overline{CS})}$ (ns) Access time from chip select (enable time)		t_{PXZ} (ns) Disable time from high or low level	
		TYP‡	MAX	TYP‡	MAX	TYP‡	MAX
SN54S287	C_L = 30 pF for $t_{a(ad)}$ and $t_{a(\overline{CS})}$ 5 pF for t_{PXZ}; R_L = 300 Ω; See Figure 4	42	75	15	40	12	40
SN74S287		42	65	15	35	12	35
SN54S288		25	50	12	30	8	30
SN74S288		25	40	12	25	8	20
SN54S471		50	80	20	40	15	35
SN74S471		50	70	20	35	15	30
SN54S472, SN54S474		55	85	20	45	15	40
SN74S472, SN74S474		55	75	20	40	15	35

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time and duration of the short-circuit should not exceed one second.
♦An SN54S287 in the W package operating at free-air temperatures above 108°C requires a heat sink that provides a thermal resistance from case-to-free-air, $R_{\theta CA}$, of not more than 42°C/W.
NOTE 4: The typical values of I_{CC} shown are with all outputs low.

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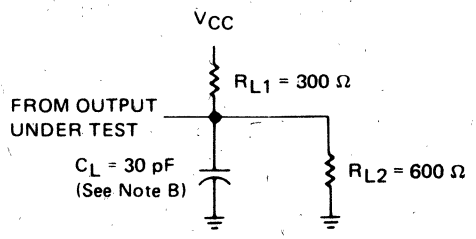
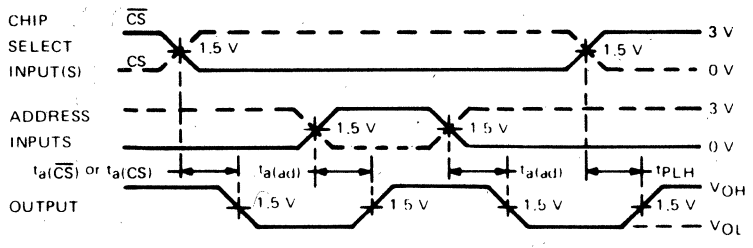
PARAMETER MEASUREMENT INFORMATION



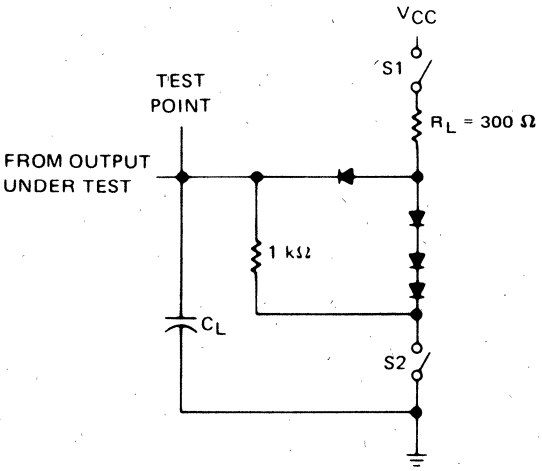
LOAD CIRCUIT



VOLTAGE WAVEFORMS

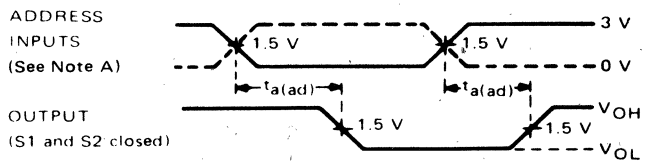
NOTES:
A. The input pulse generator has the following characteristics: $Z_{out} \approx 50\ \Omega$, PRR ≤ 1 MHz, $t_r \leq 2.5$ ns, and $t_f \leq 2.5$ ns.
B. C_L includes probe and jig capacitance.
C. The pulse generator is connected to the input under test. The other inputs, memory content permitting, are connected so that the input will switch the output under test.

FIGURE 3 – SWITCHING TIMES OF 'S188, 'S470, 'S387, 'S473, AND 'S475

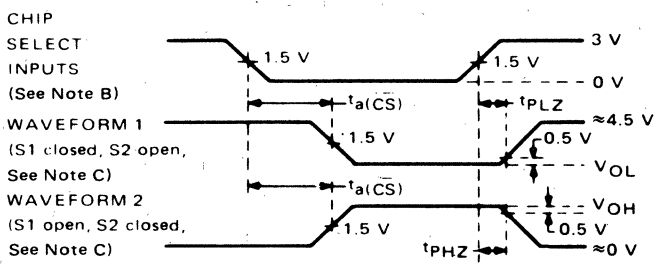


C_L includes probe and jig capacitance.
All diodes are 1N3064.

LOAD CIRCUIT



ACCESS TIME FROM ADDRESS INPUTS VOLTAGE WAVEFORMS



$t_{PXZ} = t_{PHZ}$ or t_{PLZ}

ACCESS (ENABLE) TIME AND DISABLE TIME FROM CHIP SELECT VOLTAGE WAVEFORMS

NOTES: A. When measuring access times from address inputs, the chip select input(s) is(are) low.
B. When measuring access and disable times from chip select input(s), the address inputs are steady state.
C. Waveform 1 is for the output with internal conditions such that the output is low except when disabled. Waveform 2 is for the output with internal conditions such that the output is high except when disabled.
D. Input waveforms are supplied by pulse generators having the following characteristics: $t_r \leq 2.5$ ns, $t_f \leq 2.5$ ns, PRR ≤ 1 MHz, and $Z_{out} \approx 50\ \Omega$.

FIGURE 4 – SWITCHING TIMES OF 'S287, 'S288, 'S471, 'S472, AND 'S474

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INTRODUCTION TO MICROPROCESSORS

This section briefly describes microprocessors from 28 manufacturers. It gives you a list of system components (pages 866-872) followed by detailed information from the manufacturers on key products (pages 889-1103).

The extent of information, support, and applications assistance available from manufacturers is an important factor in selecting microprocessors. Therefore, the detailed facts presented in the system descriptions include hardware and software items. The descriptions indicate whether complete operating cards are offered and indicate if "prototyping systems" or developmental operating systems are available. The listings also cover the availability of "in-system emulators." These units are usually black boxes that look to the system like a real time IC device. But by using them the designer can modify the program and can effectively gain access to what would be interior portions of the integrated circuit to test, analyze, and debug the microprocessor while it is connected to the system.

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AMD	873	Mostek	879, 880
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MICROPROCESSOR—System Components

This section presents the major microprocessor system devices organized into system groups, ie F8, 6800, 8080, etc. It includes those RAM's, ROM's and PROM's which are unique to a system. It omits most general purpose memories as they are listed in the Memory section. Similarly, buffers, line drivers, transceivers, UART's, etc. are covered briefly here as they are presented in depth in the Digital and Interface sections.

Function	Device	Source	Line
F8			
Central Processing Unit			
	3850	Fairchild	
	F8	**Fairchild (953,957)**	
	MK3850	Mostek	
Program Storage Unit			
	3851	**Fairchild (954)**	
	3857	**Fairchild (955)**	
	3856	**Fairchild (955)**	
	MK3851	Mostek	20
Microcomputer (1 chip)			
	3859	Fairchild	
	3870	Mostek	
Direct Memory Access			
	3854	**Fairchild (956)**	
	MK3854	Mostek	
Peripheral Input/Output Interface			
	3861	**Fairchild (955)**	
	MK3861	Mostek	
Dynamic Memory Interface			30
	3852	**Fairchild (956)**	
	MK3852	Mostek	
Static Memory Interface			
	3853	**Fairchild (956)**	
	MK3853	Mostek	
Peripheral Interface Adapter			
	MK3820	Mostek	
IMP			
Control Read Only Memory (CROM)			
	IMP-8A/520	**National (1043)**	40
	IMP-16	**National (986)**	
	IMP-16A/521	**National (1043)**	
	IMP-16A/522	**National (1043)**	
	IMP-16A/523	National	
	IMP-16A/524	National	
Register, Arithmetic and Logic Unit (RALU)			
	IMP-00A/520	**National (1051)**	
Macrologic Bipolar			
Microprogram Sequencer			
	9408C	Fairchild	50
	9408M	† Fairchild	
Arithmetic Logic Register-Stack			
	9405AC	Fairchild	
	9405AM	† Fairchild	
Data Path Switch (for closing data path loops around arithmetic/logic networks such as 9405)			
	9404C	Fairchild	
	9404M	† Fairchild	
Data Access Register (performs memory address arithmetic)			60
	9407C	Fairchild	
	(Continued)		

Function	Device	Source	Line
Macrologic Bipolar (Cont'd)			
Data Access Register (performs memory address arithmetic) (Continued)			
	9407M	† Fairchild	
Buffer (16x4 First-In First-Out Memory. See also Memory-FIFO's)			
	9403C	Fairchild	
	9403M	† Fairchild	70
Buffer (64x4 First-In First-Out Memory. See also Memory-FIFO's)			
	9423C	Fairchild	
	9423M	† Fairchild	
Display Controller			
	9412C	Fairchild	
	9412M	† Fairchild	
Program Stack (16x4 LIFO memory)			
	9406C	Fairchild	
	9406M	† Fairchild	80
CRC Generator/Checker (See also Interface-Error Checking Circuits)			
	9401C	Fairchild	
	9401M	† Fairchild	
RAM (16x4) Write-while-Read (See also Digital-TTL-Memories)			
	9410C	Fairchild	
	9410M	† Fairchild	
Macrologic CMOS			
Arithmetic Logic Register Stack			90
	F4705BC	Fairchild	
	F4705BM	† Fairchild	
Data Path Switch (for closing data path loops around arithmetic/logic networks such as the F4705)			
	F4704BC	Fairchild	
	F4704BM	† Fairchild	
Data Access Register (performs memory address arithmetic)			
	F4707BC	Fairchild	100
	F4707BM	† Fairchild	
Microprogram Sequencer			
	F4708C	Fairchild	
	F4708M	† Fairchild	
Parallel/Serial First-In First-Out Memory (FIFO) (See also Memory-FIFO's)			
	F4703BC	Fairchild	
	F4703BM	† Fairchild	
Program Stack (16x4 LIFO Memory)			
	F4706BC	Fairchild	110
	F4706BM	† Fairchild	
Programmable Bit Rate Generator (See also Digital-CMOS-Miscellaneous-Bit Rate Generator)			
	F4702BC	Fairchild	
	F4702BM	† Fairchild	
RAM (16x4, clocked) Write-while-Read (See also Digital-CMOS-Memories)			
	F4710BC	Fairchild	
	F4710BM	† Fairchild	
RAM (16x4) (See also Memory-RAM's)			120
	F4725BC	Fairchild	
	F4725BM	† Fairchild	

Function	Device	Source	Line
Macrologic CMOS (Cont'd)			
RAM (256x1) (See also Memory-RAM's)			
	F4720C	Fairchild	
	F4720M	† Fairchild	
RAM (256X4) (see also Memory-RAMS)			
	F4726BC	Fairchild	
	F4726BM	† Fairchild	
ROM (256X8) (see also Memory-ROMS)			130
	F4735BC	Fairchild	
	F4735BM	† Fairchild	
MicroNOVA			
CPU			
	MN601	Data Gen	
	MICRONOVA	Data Gen	
Clock Driver			
	MN637	Data Gen	
I/O Transceiver			
	MN629	Data Gen	140
I/O Transceiver Buffer			
	MN636	Data Gen	
Memory Bus Transceiver			
	MN634	Data Gen	
Intelligent I/O Controller			
	MN603	Data Gen	
RAM (4096x1)			
	MN606	Data Gen	
Sense Amplifier (for MN606)			
	MN506	Data Gen	150
PACE			
Processing and Control Element (PACE) (CPU)			
	IPC-16A/520	**National (1022)**	
	PACE	**National (986,1022,1077)**	
Address Latch Element (ALE)			
	IPC-16A/518	National	
Bidirectional Transceiver-Element (BTE)			
	DP8300	**National (458)**	
Bidirectional Bus Transceiver			160
	DP8304	**National (472)**	
Interface Latch Elements (ILE)			
	DP8301	National	
System Timing Element (STE)			
	DP8302	**National (466)**	
Erasable PROM (See also Memory-PROM's MM5204)			
	IPC-16A/506	National	
RAM (256x4) (See also Memory-RAM's, MM5269)			
	IPC-16A/504	National	170
ROM (512x8) (See also Memory-ROM's, MM5214)			
	IPC-16A/507	National	
ROM (1024x16)			
	IPC-16A/505	National	

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

MICROPROCESSOR—System Components (Cont'd)

Function	Device	Source	Line
PPS-4, PPS-8			
CPU (for PPS-4)			
	12660	Rockwell	
ROM-RAM (for PPS-4)			
	A07XX	Rockwell	
	A08XX	Rockwell	
	A20XX	Rockwell	
CPU (for PPS-4/1)			
	76XX	Rockwell	
	77XX	Rockwell	10
CPU Evaluation Circuit (for PPS-4/1)			
	6799	Rockwell	
CPU (for PPS-4/2)			
	11600	Rockwell	
ROM-RAM (for PPS-4/2)			
	A17XX	Rockwell	
CPU (for PPS-8)			
	11806	Rockwell	
CPU (for PPS-8/2)			
	12806	Rockwell	20
ROM-RAM (for PPS 8/2)			
	A21XX	Rockwell	
Bus Interface Circuit (BIC)			
	10738	Rockwell	
Clock Generator (CLK) (for PPS-4, PPS-8)			
	10706	Rockwell	
Direct Memory Access Controller (DMA) (for PPS-8)			
	10817	Rockwell	
Display Controller (DC)			30
	10814	Rockwell	
Floppy Disk Controller (FDC) (for PPS-8)			
	10936	Rockwell	
General Purpose Keyboard and Display Control (GPKD)			
	10788	Rockwell	
General Purpose Input/Output (GPI/O)			
	10696	Rockwell	
Interval Timer			
	11049	Rockwell	40
Keyboard/Printer Controller (KPC)			
	10815	Rockwell	
Printer Controller (PC)			
	10789	Rockwell	
Victor Dot Matrix Printer Controller (VPC)			
	10736	Rockwell	
	15380	Rockwell	
Parallel Data Controller (PDC) (for PPS-8, PPS-8/12)			
	10453	Rockwell	50
Serial Data Controller (SDC)			
	10930	Rockwell	
Telecommunications Data Interface (includes modem)			
	10371	Rockwell	
RAM (256x4) (for PPS-4, PPS-4/2)			
	10432	Rockwell	

Function	Device	Source	Line
PPS-4, PPS-8 (Cont'd)			
RAM (512x4) (for PPS-4, PPS-4/2)			
	10932	Rockwell	60
RAM (256x8) (for PPS-8, PPS-8/2)			
	10809	Rockwell	
4K RAM Interface			
	10929	Rockwell	
RAM (4096x1) (See also Memory-RAM's)			
	1604-8	Rockwell	
ROM (1024x8)			
	A05XX	Rockwell	
ROM (2048x8)			
	A52XX	Rockwell	70
ROM (4096x8)			
	A66XX	Rockwell	
SBP0400			
CPU, 4-Bit Slice			
	SBP0400AC	**TI**	**(1102)**
	SBP0400AM	**† TI**	**(1102)**
	SBP0401A	**TI**	**(1103)**
SC/MP			
Microprocessor			
	ISP-8A/500	**National**	**(998)** 80
	SC/MP	**National**	**(986,998,1077)**
8-Bit I/O Port			
	DP8212	**National**	**(439)**
Programmable Communication Interface (USART. See also Interface-Transmitters-Receivers)			
	DP8251	National	
Programmable Peripheral Interface			
	DP8255	National	
SX200			90
Microcomputer			
	SX200	Essex	
TLCS-12			
CPU			
	T3190	Toshiba	
Input/Output Control Unit			
	T3218	Toshiba	
General Purpose Input/Output Register			
	T3320	Toshiba	
Memory Control Unit			100
	T3216	Toshiba	
Erasable PROM			
	T3181	Toshiba	
RAM (128x4)			
	T3151	Toshiba	
Z80			
Note: the 6500, 6800 and 8080 peripheral circuits are compatible with the Z80 series.			
CPU			
	MK3880	Mostek	110
	Z80-CPU	Zilog	

Function	Device	Source	Line
Z80 (Cont'd)			
Counter Timer Circuit			
	MK3882	Mostek	
	Z80-CTC	Zilog	
Direct Memory Access Controller			
	MK3883	Mostek	
	Z80-DMA	Zilog	
Parallel Input/Output Controller			
	MK3881	Mostek	120
	Z80-PIO	Zilog	
Serial Input/Output Controller			
	MK3884	Mostek	
	Z80-SIO	Zilog	
1000			
Microcomputer			
	TMS1000	**TI**	**(1090)**
	TMS1070	TI	
	TMS1100	TI	
	TMS1200	TI	130
	TMS1270	TI	
	TMS1300	TI	
Program Development Device (uses external memory)			
	TMS1098	TI	
	TMS1099	TI	
1600			
See also 1600 below.			
Microprocessor			
	CP-1600	EMM/Semi	140
	CP-1600A	EMM/Semi	
	CP-1600	GI	
	CP-1600A	GI	
Programmable Interface Controller			
	PIC1640	GI	
	PIC1650	GI	
Dual D/A Converter			
	DAC1600	GI	
Input/Output Buffer			
	IOB1680	GI	150
1600			
See also 1600 above.			
CPU, 8-Bit			
	CP1651	Western	
	CP1661	Western	
CPU, 16-Bit			
	MP1651	Western	
	MP1661	Western	
General Purpose Input/Output			
	CP1851	Western	160
Microm			
	CP1631	Western	
Direct Memory Access Controller			
	DM1881	Western	
Floppy Disc Controller/Transmitter			
	FD1771	Western	

† Military Temperature Range (−55°C to 125°C)

MICROPROCESSOR—System Components (Cont'd)

1600 (Cont'd)

Function	Device	Source
Asynchronous/Synchronous Transmitter/Receiver (ASTRO) (See also Interface-Serial Transmitters-Receivers)		
	UC1671	Western

1800

Function	Device	Source
CPU		
	HMPC1802	† Hughes
	CDP1802	† RCA
	CDP1802C	† RCA
Control Unit (half of 2 device CPU)		
	CDP1801CU	† RCA
	CDP1801U	† RCA
Register Unit (half of 2 device CPU)		
	CDP1801CR	† RCA
	CDP1801R	† RCA
8-Bit Input/Output Port		
	CDP1852	† RCA
	CDP1852C	† RCA
4-Bit Buffer/Separator (for memory interface)		
	CDP1856	† RCA
	CDP1856C	RCA
4-Bit Bus Buffer/Separator (for I/O interface)		
	CDP1857	† RCA
	CDP1857C	RCA
UART		
	CDP185A	† RCA
	CDP1854C	RCA
RAM (32x8) (See also Memory-RAM's)		
	CDP1824	† RCA
	CDP1824C	† RCA
RAM (256x4) (See also Memory-RAM's)		
	CDP1822C	† RCA
	CDP1822SC	† RCA
RAM (1024x1) (See also Memory-RAM's)		
	CDP1821S	† RCA
	CDP1821SC	† RCA
ROM (512x8) (See also Memory-ROM's)		
	CDP1831	† RCA
	CDP1831C	† RCA
	CDP1832	† RCA
	CDP1832C	† RCA

2650

Function	Device	Source
Microprocessor		
	2650	Intersil
	2650	Signetics
Hex Buffers/Inverters (See also Digital-TTL-Buffers/Inverters 8T95, 8T96, 8T97, 8T98)		
	MC8T95	Motorola
	MC8T96	Motorola
	MC8T97	Motorola
	MC8T98	Motorola
	N8T95	Signetics
	N8T96	Signetics
	N8T97	Signetics
	N8T98	Signetics
Bidirectional Port		
	N8T31	Signetics

2650 (Cont'd)

Function	Device	Source
Programmable Communication Interface		
	2651	Intersil
	2651	Signetics
Synchronous Data Link Control (SDLC)		
	2652	Intersil
	2652	Signetics
Programmable Peripheral Interface		
	2655	Intersil
	2655	Signetics
Direct Memory Access		
	2657	Intersil
	2657	Signetics
System Memory Interface		
	2656	Intersil
	2656	Signetics
Quad Transceivers (See also Interface-Line Transceivers)		
	N8T26	AMD
	MC8T26	Motorola
	MC8T28	Motorola
	N8T26	Signetics
	N8T28	Signetics
Field Programmable Logic Array (See also Memory-PLA's)		
	82S100	Signetics
	82S101	Signetics

2900

Function	Device	Source
Microprocessor, 4-Bit Slice		
	AM2901C	AMD
	AM2901M	† AMD
	MC2901C	Motorola
	MC2901M	† Motorola
	AM2901C	Raytheon
	AM2901M	† Raytheon
Look-Ahead Carry Generator		
	AM2902C	AMD
	AM2902M	† AMD
Microprogram Sequencer		
	AM2909C	AMD
	AM2909M	† AMD
	AM2911C	AMD
	AM2911M	† AMD
	MC2909C	Motorola
	MC2909M	† Motorola
	AM2909C	Raytheon
	AM2909M	† Raytheon
Macroprogram Sequencer		
	AM2919C	AMD
	AM2919M	† AMD
Priority Interrupt Encoder, Vectored		
	AM2914C	AMD
	AM2914M	† AMD
Priority Interrupt Expander (for 2914)		
	AM2913C	AMD
	AM2913M	† AMD
Bus Transceivers (See also Interface-Line Transceivers)		
	AM2905C	AMD
	AM2905M	† AMD

(Continued)

2900 (Cont'd)

Function	Device	Source
Bus Transceivers (See also Interface-Line Transceivers) (Continued)		
	AM2906C	AMD
	AM2906M	† AMD
	AM2907C	AMD
	AM2907M	† AMD
	AM2915C	AMD
	AM2915M	† AMD
	AM2916C	AMD
	AM2916M	† AMD
	AM2917C	AMD
	AM2917M	† AMD
	MC2915C	Motorola
	MC2915M	† Motorola
	MC2916C	Motorola
	MC2916M	† Motorola
	MC2917C	Motorola
	MC2917M	† Motorola
	AM2905C	Raytheon
	AM2905M	† Raytheon
	AM2906C	Raytheon
	AM2906M	† Raytheon
	AM2907C	Raytheon
	AM2907M	† Raytheon
Quad D Register with both Standard and Three-State Outputs (See also Digital-TTL-Flip-Flops)		
	AM2918C	AMD
	AM2918M	† AMD
	MC2918C	Motorola
	MC2918M	† Motorola
	AM2918C	Raytheon
	AM2918M	† Raytheon
PROM (32x8) (See also Memory-PROM's)		
	AM29750C	AMD
	AM29750M	† AMD
	AM29751C	AMD
	AM29751M	† AMD
PROM (256x4) (See also Memory PROM's)		
	AM29760C	AMD
	AM29760M	† AMD
	AM29761C	AMD
	AM29761M	† AMD
RAM (16x4) Two output ports		
	AM29704C	AMD
	AM29704M	† AMD
	AM29705C	AMD
	AM29705M	† AMD
RAM (16x4) (See also Memory-RAM's)		
	AM29700C	AMD
	AM29700M	† AMD
	AM29701C	AMD
	AM29701M	† AMD
	AM29702C	AMD
	AM29702M	† AMD
	AM29703C	AMD
	AM29703M	† AMD
RAM (256x1) (See also Memory-RAM,s)		
	AM29720C	AMD
	AM29720M	† AMD
	AM29721C	AMD
	AM29721M	† AMD

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

MICROPROCESSOR—System Components (Cont'd)

Function	Device	Source	Line
2900 (Cont'd)			
ROM (1024x8) (See also Memory-ROM,s)			
	AM29882C	AMD	
	AM29883C	AMD	
3000			
Central Processing Element, 2-Bit slice			
	3002	Intel	
	M3002	† Intel	
	N3002	Signetics	
Microprogram Control Unit			10
	3001	Intel	
	M3001	† Intel	
	N3001	Signetics	
Parallel Bidirectional Bus Driver			
	3216	Intel	
	M3216	† Intel	
	3226	Intel	
	M3226	† Intel	
Interrupt Control Unit			
	3214	Intel	20
	M3214	† Intel	
Look-Ahead Carry Generator			
	3003	Intel	
	M3003	† Intel	
Multimode Latch Buffer			
	3212	Intel	
	M3212	† Intel	
4004/4040			
CPU			
	4004	Intel	30
	4040	Intel	
	INS4004	**National (1059)**	
Clock Generator			
	4201	Intel	
	DP4201	**National (435)**	
Programmable General Purpose I/O			
	4265	Intel	
Programmable Keyboard/Display Device			
	4269	Intel	
Standard Memory and I/O Interface			40
	4008	Intel	
	4009	Intel	
	4289	Intel	
	INS4008	**National (1059)**	
	INS4009	**National (1059)**	
10-Bit Shift Register/Output Expander			
	4003	Intel	
	INS4003	**National (1059)**	
Erasable PROM (256x8) (See also Memory-PROM's, 1702A)			50
	4702	AMD	
	4702A	Intel	
	INS4702	National	
320-Bit RAM and 4-Bit Output Port			
	4002	Intel	
	INS4002	**National (1059)**	

Function	Device	Source	Line
4004/4040 (Cont'd)			
RAM (256x4) (See also Memory-RAM's, 2101 series)			
	4101	Intel	60
ROM (256x8) and 4-Bit I/O Port			
	4001	Intel	
	INS4001	**National (1059)**	
ROM (1024x8) and I/O Ports			
	4308	Intel	
ROM (2048x8) (See also Memory-ROM's, 2316A)			
	4316A	Intel	
54/74S480			
4-Bit Microprocessor Slice			
	SN54S481	**† TI (1098)**	70
	SN74S481	**TI (1098)**	
Control Element (for next address generators)			
	SN54S482	**† TI (1099)**	
	SN74S482	**TI (1099)**	
Field Programmable Logic Array			
	SN54S330	**† TI (1100)**	
	SN74S330	**TI (1100)**	
	SN54S331	**† TI (1101)**	
	SN74S331	**TI (1101)**	
67000			80
Microcontroller			
	57001	† MMI	
	67001	MMI	
Microprogram Control Unit			
	57110	† MMI	
	67110	MMI	
DMA Controller			
	6717	MMI	
FIFO Memory (64x4) (See also Memory-FIFO's)			
	57401	† MMI	90
	67401	MMI	
I/O Controller			
	6718	MMI	
Multiplier (8x8)			
	57588	† MMI	
	67558	MMI	
Multiplier/Divider (16x16)			
	57516	† MMI	
	67516	MMI	
Priority Interrupt			100
	57116	† MMI	
	67116	MMI	
5781/82			
Microprocessor			
	MM5782	National	
Control ROM (2048x8)			
	MM5781	National	
RAM Interface			
	MM5785	National	

Function	Device	Source	Line
5799			110
Microprocessor			
	MM5799	National	
Printer Interface			
	MM5788	National	
Oscillator, Decoder, Driver			
	DS8664	National	
RAM Interface			
	MM5785	National	
6100			
CPU			120
	HM6100-2	**† Harris (968)**	
	HM6100-9	**† Harris (968)**	
	IM6100C	Intersil	
	IM6100M	† Intersil	
Parallel Interface Element			
	HD6101A-2	**† Harris (982)**	
	HD6101A-9	**Harris (982)**	
	IM6101A	Intersil	
	IM6101AM	† Intersil	
Universal Asynchronous Receiver-Transmitter (UART) (See also Interface-Serial Transmitters-Receivers)			130
	HD6402-2	**† Harris (976)**	
	HD6402-9	**Harris (976)**	
	HD6403-2	**† Harris (976)**	
	HD6403-9	**Harris (976)**	
	IM6402	Intersil	
	IM6402M	† Intersil	
	IM6403	Intersil	
	IM6403M	† Intersil	140
6500			
Note: The 6500 series is bus compatable with 6800 series devices			
CPU			
	MCS6502	MOS	
	MCS6503	MOS	
	MCS6504	MOS	
	MCS6505	MOS	
	MCS6506	MOS	
	MCS6512	MOS	150
	MCS6514	MOS	
	MCS6515	MOS	
	SY6502	Synertek	
	SY6503	Synertek	
	SY6504	Synertek	
	SY6505	Synertek	
	SY6506	Synertek	
	SY6512	Synertek	
	SY6514	Synertek	
	SY6515	Synertek	160
RAM, ROM, I/O and Interval Timer			
	MCS6530	MOS	
	MCS6532	MOS	
	SY6530	Synertek	
	SY6532	Synertek	
Peripheral Interface Adapter			
	MCS6520	MOS	
	MCS6522	MOS	
	SY6520	Synertek	
	(Continued)		170

† Military Temperature Range (−55°C to 125°C)

MICROPROCESSOR—System Components (Cont'd)

6500 (Cont'd)

Peripheral Interface Adapter (Continued)

Device	Source
SY6522	Synertek

ROM (2048x8) (See also Memory-ROM's)

Device	Source
SY6540	Synertek
SY6541	Synertek

6800

Note: The 6800 series is bus compatable with the 6500 series devices.

CPU

Device	Source	Line
S6800	**AMI (889,903)**	10
F6800	Fairchild	
M6800	Hitachi	
MC6800	Motorola	

Priority Interrupt Controller

Device	Source
F6828	Fairchild
MC6828	Motorola
MC8507	Motorola

Hex Buffers/Inverters (See also Digital-TTL-Buffers/Inverters 8T95, 8T96, 8T97, 8T98) — Line 20

Device	Source
MC6885	Motorola
MC6886	Motorola
MC6887	Motorola
MC6888	Motorola

Triple Bidirectional Bus Switch (also MC3449)

Device	Source
MC6881	Motorola

Clock, 2 phase (MC6870/71 from Motorola Component Products Dept., Franklin Park, IL) — Line 30

Device	Source
MC6870	Motorola
MC6871	Motorola
MC6875	Motorola

Clock Buffer

Device	Source
MPQ6842	Motorola

Digital Modulator (for differential phase shift keying system)

Device	Source
MC6862	Motorola

Modem — Line 40

Device	Source
S6860	**AMI (889,940)**
F6860	Fairchild
MC6860	Motorola

Synchronous Serial Data Adapter (SSDA)

Device	Source
S6852	AMI
F6852	Fairchild
MC6852	Motorola

Synchronous Receiver/Transmitter (UART. See also Interface-Serial Transmitters-Receivers) — Line 50

Device	Source
S2350	**AMI (400,889,945)**

Asynchronous Communications Interface Adapter (ACIA)

Device	Source
S6850	**AMI (400,889,935)**
F6850	Fairchild
MC6850	Motorola

Peripheral Interface Adapter, (PIA) — Line 60

Device	Source
S6820	**AMI (889,919)**
F6820	Fairchild
MK6820	Mostek

(Continued)

6800 (Cont'd)

Peripheral Interface Adapter, (PIA) (Continued)

Device	Source
MC6820	Motorola

Bus Transceiver, (The 6880 is also called 8T26 and the 6889 the 8T28, See Interface-Transceivers) — Line 70

Device	Source
MC6880	Motorola
MC6889	Motorola

Erasable PROM (1024x8) (See also Memory-PROM's)

Device	Source
MCM68708	Motorola

Erasable PROM (512x8) (See also Memory-PROM's) — Line 80

Device	Source
S5204A	**AMI (655,952)**
S6834	**AMI (889,661,930)**

RAM (128x8) (See also Memory-RAM's)

Device	Source
S6810	**AMI (889,649,916)**
MCM6810A	Motorola

ROM (1024x8) (See also Memory-ROM's)

Device	Source
S6830	**AMI (889,659,925)**
MCM6830A	Motorola
MCM68308	Motorola

ROM (2048x8) (See also Memory-ROM's) — Line 90

Device	Source
S6831	**AMI (889,660,927)**
MCM68317	Motorola

8X300

Microprocessor

Device	Source
8X300	Signetics
SMS300	SMS

I/O Port, Synchronous, Field Programmable Address — Line 100

Device	Source
8T32	Signetics
8T33	Signetics
SMS360	SMS
SMS361	SMS

I/O Port, Asynchronous, Field Programmable Address

Device	Source
8T35	Signetics
8T36	Signetics
SMS362	SMS
SMS363	SMS

Bus Extender — Line 110

Device	Source
8T39	Signetics

8000

Logic Processor

Device	Source
LP8000	GI

Clock Generator

Device	Source
LP1030	GI

Input/Output Buffer

Device	Source
LP1010	GI

Memory Interface

Device	Source
LP1000	GI

Program Memory (1024x8) — Line 120

Device	Source
LP6000	GI

8008

CPU

Device	Source
8008	Intel

8-Bit I/O Port (See listing under 8080)

Device	Source
8212	Intel

Bidirectional Bus Driver (See listing under 8080) — Line 130

Device	Source
8216	Intel
8226	Intel

Programmable Interval Timer

Device	Source
8253	Intel

Programmable Peripheral Interface (See listing under 8080)

Device	Source
8255	Intel

8080

See also Z80

CPU — Line 140

Device	Source
9080-AC	AMD
9080AM	† AMD
8080A	Intel
M8080A	† Intel
M58710S	Mitsubishi
μPD8080A	NEC
DP8080A	**National (1033)**
TMS8080A	**TI (1097)**

Bidirectional Bus Driver (See also Digital-Miscellaneous-Bus Drivrs; Interface-Line Transceivers.) — Line 150

Device	Source
8216	AMD
8226	AMD
8216	Intel
M8216	† Intel
8226	Intel
μPB8216	NEC
DS8833	National
DS8835	National

Clock, Generator and Driver — Line 160

Device	Source
8224C	AMD
8224M	† AMD
8224	Intel
M8224	† Intel
μPB8224	NEC
DP8224	**National (447)**
SN54LS424	† TI
SN74LS424	TI
TIM8224	TI

Cassette Controller

Device	Source
μPD371	NEC

Asynchronous Communication Element — Line 170

Device	Source
DP82501	National

Programmable Communication Interface (USART) (See also Interface-Transmitters,Receivers)

Device	Source
9551C	AMD
9551M	† AMD
8251	Intel
M8251	† Intel
DP8251	National
μPD8251	NEC
TMS5501	**TI (1096)**

Decoder, 1 of 8 (See also Digital-TTL-Decoders, 3222, 74LS138, etc.) — Line 180

Device	Source
AM25LS138C	AMD

(Continued)

† Military Temperature Range (−55°C to 125°C)

Bold face indicates additional data is provided on the page noted.

MICROPROCESSOR—System Components (Cont'd)

8080 (Cont'd)

Decoder, 1 of 8 (See also Digital-TTL-Decoders, 3222, 74LS138, etc.) (Continued)

Device	Source
AM25LS138M	† AMD
8205	Intel
DM74LS138	National
SN74LS138	TI

Programmable Direct Memory Access Controller

Device	Source
8257	AMD
8257	Intel
μPD8257	NEC

Floppy Disc Controller

Device	Source
μPD372	NEC

Programmable I/O Circuit

Device	Source
EA9255	EA

General Interface Circuit

Device	Source
μPC6001	SMC

8-Bit I/O Port

Device	Source
8212C	AMD
8212M	† AMD
8212	Intel
M8212	† Intel
μPB8212	NEC
DP8212	**National (439)**
SN54S412	† TI
SN74S412	TI

Multifunction I/O Controller, (asynchronous communications interface, I/O buffers, interrupt control, interval timers)

Device	Source
TMS5501	**TI (1096)**

Priority Interrupt Control

Device	Source
AM2914C	AMD
AM2914M	† AMD
8214	Intel
M8214	† Intel
μPB8214	NEC

Programmable Interrupt Controller

Device	Source
8259	AMD
8259	Intel
μPD8259	NEC

Programmable Interval Timer

Device	Source
8253	Intel
μPD8253	NEC

Programmable Peripheral Interface

Device	Source
9555C	AMD
9555M	† AMD
8255	Intel
M8255	† Intel
DP8255	National
μPD8255	NEC

System Controller and Bus Driver

Device	Source
8228C	AMD
8228M	† AMD
8238C	AMD
8238M	† AMD
8228	Intel
M8228	† Intel
8238	Intel
DP8228	**National (453)**
DP8238	**National (453)**
μPB8228	NEC

(Continued)

8080 (Cont'd)

System Controller and Bus Driver (Continued)

Device	Source
μPB8238	NEC
SN74S428	TI
TIM8228	TI

Erasable PROM (256x8) (See also Memory-PROM's, 1702A series)

Device	Source
8702A	AMD
8702A	Intel
M8702A	† Intel
MM1702A	**National (818)**
μPD454	NEC

Erasable PROM (1024x8) (See also Memory-PROM's 2708)

Device	Source
8708	Intel
M8708	† Intel
μPD458	NEC
TMS4908	TI

RAM (256x4) (See also Memory-RAM's 2101, 2111 series)

Device	Source
8101	AMD
8111	AMD
8101A-4	Intel
8111A-4	Intel
MM2101	**National (756)**
MM2111	**National (768)**
μPD2101	NEC
μPD2111	NEC

RAM (1024x1) (See also Memory-RAM's 2101A series)

Device	Source
8102A-4	AMD
8102A-4	Intel
M8102A	† Intel
μPD2102	NEC

RAM (4096x1) (See also Memory-RAM's 2107B, 5580 series)

Device	Source
8107B-4	Intel

ROM (256x8) (See also Memory-ROM's 1302)

Device	Source
8302	Intel
MM5213	National
DP8302	**National (466)**

ROM (1024x8) (See also Memory-ROM's 2308)

Device	Source
9208	AMD
8308	Intel
MM5242	**National (832)**
μPD2308	NEC

ROM (2048x8) (See also Memory-ROM's 2316A)

Device	Source
8316A	AMD
9216	AMD
8316A	Intel
M8316	† Intel
MM2316A	**National (830)**
μPD2316	NEC

9002

The 9002 is interface compatable with most 6500, 6800, and 8080 peripheral devices.

Microprocessor

Device	Source
EA9002	EA

Keyboard Encoder/Display Scanner (See also Interface-Keyboard Encoder-Decoders)

Device	Source
EA9250	EA

9002 (Cont'd)

Printer Controller (Seiko)

Device	Source
μPD758	NEC

9080

See 8080 series

9900

Microprocessor

Device	Source
SBP9900	† TI
TMS9900	**TI (1092)**
TMS9980	**TI (1094)**

Clock Generator and Driver (4-phase for 9900)

Device	Source
SN54LS362	† TI
SN74LS362	TI
TIM9904	**TI (1096)**

Data Selector/Multiplexer (See also Digital-TTL-Multiplexers 74LS251)

Device	Source
SN54LS251	† TI
SN74LS251	TI
TIM9905	TI

Priority Encoder (See also Digital-TTL-Miscellaneous-Priority Encoder-74148)

Device	Source
SN74148	TI

Programmable Systems Interface (interrupt prioritization, I/O control and interval timing)

Device	Source
TMS9901	**TI (1094)**

Synchronous Communication Controller (Bi-Sync and SDLC)

Device	Source
TMS9903	**TI (1095)**

Asynchronous Communication Controller (UART) (See also Interface-Serial Transmitters-Receivers)

Device	Source
TMS6011	TI
TMS9902	**TI (1095)**

Programmable CRT Controller

Device	Source
SBP9920	TI

8-Bit Addressable Latch

Device	Source
SN54LS259	† TI
SN74LS259	TI
TIM9906	TI

10800

Arithmetic Logic Unit, 4-Bit Slice

Device	Source
MC10800	Motorola

Microprogram Control Function

Device	Source
MC10801	Motorola

Memory Interface

Device	Source
MC10803	Motorola

Timing Function

Device	Source
MC10802	Motorola

Memories (See Digital-ECL-Memories and Memory-PROM's/ROM's)

General Purpose

Sequence Controller

Device	Source
57110	† MMI
67110	MMI

Deskew FIFO (to synchronize data from magnetic tape storage systems)

Device	Source
8X03	Signetics
8X04	Signetics

† Military Temperature Range (−55°C to 125°C)

MICROPROCESSOR—System Components (Cont'd)

General Purpose (Cont'd)

Function	Device	Source	Line
Control Sequencer (to control fetch sequence of microinstructions)			
	8X02	Signetics	
Priority Interrupt Controller			
	MC6828	Motorola	
	MC8507	Motorola	
Floppy Disc Controller/Transmitter (IBM 3740 compatible)			
	FD1771	Western	10
Floppy Disc Controller			
	μPD372	NEC	
Cassette Controller			
	μPD371	NEC	
Synchronous Serial Data Adapter			
	S6852	AMI	
	MC6852	Motorola	
Asynchronous Communication Interface Adapter			
	S6850	**AMI (400,889,935)**	20
	MC6850	Motorola	
Peripheral Interface Adapter			
	S6820	**AMI (889,919)**	
	MCS6520	MOS	
	MCS6522	MOS	
	MK6820	Mostek	
	MC6820	Motorola	
	SY6520	Synertek	
	SY6522	Synertek	30

See also Interface-Error Checking Circuits, Keyboard Encoders, Line, Memory and Peripheral Drivers; Memory-EAROM's, FIFO's, LIFO's, PLA's, PROM's, RAM's, ROM's.

† Military Temperature Range (−55°C to 125°C)

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MICROPROCESSORS

Manufacturer Model For Detailed Data See:	AMD 2901	AMD 9080A	AMI S6800 Page 889	Data General mN601
General Structure	4-Bit Slice	8-Bit CPU	8-Bit CPU	16-Bit CPU
Type	TTL	NMOS	NMOS	NMOS
No. of Devices per CPU		1	1	1
CPU Size (Pins)	40	40	40	40
Supply Voltage	5	±5, 12	5	±5, 15
CPU Power Dissipation (mw)	925	820	600	1000
Architecture				
Data Word Size (bits)	Multiple of 4	8	8	16
Instruction Word Size (bits)	9	8, 16, 24	8, 16, 24	16
Directly Addressable Instruction Words (No.)		65K	65K	32K
Clock Frequency (Hz/ext. phases required)	to 10 MHz/1 phase	to 4 MHz/2 phase	1 MHz/2 phase	8.3 MHz/2 phase
Register to Register Add Time (μsec/data word)	0.125	2 (2 MHz clock)	2	2.4
No. of Registers Arithmetic	0	1	2	
Index	0	0	1 (16 bit)	2
General Purpose	17	6	0	4
Return Stack Size (No. x bits)	4x4 (2909)	External RAM	External RAM	External RAM
Interrupts	Optional	Standard	Standard	Standard
Type		Vectored 8 Level	Vectored, Multilevel	16 Levels
Direct Memory Access	Optional (2914)	Standard	Optional	Standard
BCD Arithmetic (Hardware)	No	Yes	Yes	No
Microprogrammable	Yes	No	No	No
Extended Temp. Range Available	-55°C to 125°C	-55°C to 125°C	No	No
Devices See System Components	2900	8080	6800	Micro Nova
Hardware Support Processor Cards (CPU system on a card)	No	No	Yes	Yes
Prototyping System (Hardware and software development system)	No	No	Yes	Yes
In-System Emulator (Tests system in place)	No	No	Yes	No
Software Support (from this manufacturer) Resident Assembler	No	No	Yes	Yes
Cross Assembler	No	No	Fortran IV	Yes
Simulator	No	No	Fortran IV	Yes
High Level Language	No	No	No	Fortran
Programs Debug	No	No	Yes	Yes
Diagnostic	No	No	Yes	Yes
Edit	No	No	Yes	Yes
User Library (>25 programs from user)	No	No	No	Yes
Delivery Start (Qtr.-Year)	3 Qtr. 75	3 Qtr. 75	1 Qtr. 75	3 Qtr. 76
Alternate Sources	Motorola, Raytheon	Nat'l, NEC, Intel, TI 8080A	Fairchild, Hitachi, Motorola	None
Comments		Priority interrupts with Intel 8214.	DMA through HALT and three state control.	

Tinted column indicates additional data is provided on the page noted.

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MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	Electronic Arrays EA9002	EMM/SEMI CP-1600/A	Essex SX200	Fairchild Macrologic Bipolar
General Structure	8-Bit CPU	16-Bit CPU	4-Bit CPU	4-Bit Slice
Type	NMOS	NMOS	PMOS	TTL
No. of Devices per CPU	1	1	1	
CPU Size (Pins)	28	40	28	24
Supply Voltage	5	-3, 5, 12	15	5
CPU Power Dissipation (mw)	600	750	150	800
Architecture Data Word Size (bits)	8	16	4	Multiple of 4
Instruction Word Size (bits)	8, 16	10, 20, 30	8	3
Directly Addressable Instruction Words (No.)	4K	65K	1K	
Clock Frequency (Hz/ext. phases required)	4 MHz/1 phase	5 MHz/2 phase	to 500/0 phase	to 14 MHz/1 phase
Register to Register Add Time (μsec/data word)	2	2.4	16	0.10
No. of Registers Arithmetic	1	0	1	0
Index	0	0	1	0
General Purpose	8	8	0	8
Return Stack Size (No. x bits)	7x12	External RAM	1x10	10x4 (9408), 16x4 (9406)
Interrupts	Standard	Standard	None	Optional
Type	Vectored, 1 Level	Vectored, Multilevel		
Direct Memory Access	Optional	Standard	None	
BCD Arithmetic (Hardware)	Yes	No	Yes	No
Microprogrammable	No	No	No	Yes
Extended Temp. Range Available			-40°C to 100°C Std.	-55°C to 125°C
Devices See System Components:	9002	1600	SX200	Macrologic Bipolar
Hardware Support Processor Cards (CPU system on a card)	Yes	Yes	No	Yes
Prototyping System (Hardware and software development system)	Yes	Yes	Yes	Yes
In-System Emulator (Tests system in place)	Yes	No	Yes	No
Software Support (from this manufacturer) Resident Assembler	Yes	Yes	No	No
Cross Assembler	Fortran IV, Timesharing	Fortran IV	Fortran	No
Simulator	Yes	Fortran IV	Yes	No
High Level Language	No	No	No	No
Programs Debug	No	Yes	No	No
Diagnostic	No	Yes	No	No
Edit	Yes	Yes	No	No
User Library (>25 programs from user)	No	No	No	No
Delivery Start (Qtr.-Year)	2 Qtr. 76	1 Qtr. 76	2 Qtr. 76	4th Qtr. 75
Alternate Sources	None	General Instrument	None	None
Comments	DMA through addition of three state level to address bus.	CP-1600 2.4 sec add time with 3.3 MHz clock		Hardware stack with 9406

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MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	Fairchild Macrologic CMOS	Fairchild F8 Page 953	Fairchild F6800	Fairchild 3859
General Structure	4-Bit Slice	8-Bit CPU	8-Bit CPU	8-Bit CPU
Type	CMOS	NMOS	NMOS	NMOS
No. of Devices per CPU		1	1	1
CPU Size (Pins)	24	40	40	40
Supply Voltage	3 to 15	5, 12	5	5, 12
CPU Power Dissipation (mw)	to 5mw at 10V	300	600	600
Architecture Data Word Size (bits)	Multiple of 4	8	8	8
Instruction Word Size (bits)	4	8, 16, 24	8, 16, 24	8, 16, 24
Directly Addressable Instruction Words (No.)		65K	65K	1K
Clock Frequency (Hz/ext. phases required)	to 4.9 MHz (15V)/1 phase	2 MHz/0 phase	1 MHz/2 phase	2 MHz/0 phase
Register to Register Add Time (μsec/data word)	0.086 (15V)	2	2	2
No. of Registers Arithmetic	1	1	2	1
Index	2	2	1 (16-bit)	5
General Purpose	2	64	0	64
Return Stack Size (No. x bits)		33x16 or RAM	External RAM	1x8 or RAM
Interrupts		Standard	Standard	Standard
Type		Vectored, 1 Level/PSU	Vectored, Multilevel	Vectored, 1 Level
Direct Memory Access		Optional (3854)	Optional	None
BCD Arithmetic (Hardware)	No	Yes	Yes	Yes
Microprogrammable	Yes	No	No	No
Extended Temp. Range Available	-55°C to 125°C	-55°C to 125°C	Future	Future
Devices See System Components:	Macrologic CMOS	F8	6800	F8
Hardware Support Processor Cards (CPU system on a card)	No	Yes	Yes	Yes
Prototyping System (Hardware and software development system)	No	Yes	Yes	Yes
In-System Emulator (Tests system in place)	No	Yes	Yes	Yes
Software Support (from this manufacturer) Resident Assembler	No No	Yes	Yes	Yes
Cross Assembler	No	Fortran IV	Fortran IV	Fortran IV
Simulator	No	Prototyping Sys. Fortran IV	Fortran IV	Timesharing
High Level Language	No	No	MPL	No
Programs Debug	No	Yes	Yes	Yes
Diagnostic	No	Yes	Yes	Yes
Edit	No	Yes	Yes	Yes
User Library (>25 programs from user)	No	Yes	No	No
Delivery Start (Qtr.-Year)	2 Qtr. 75	1 Qtr. 75	1 Qtr. 77	2 Qtr. 77
Alternate Sources		Mostek	AMI, Motorola	None
Comments		64 bytes of RAM in CPU 1024 bytes of ROM in PSU. Programmable Timer.	DMA through HALT and three state control	1 chip microcomputer version of F8

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MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	General Instrument CP-1600/A	General Instrument LP-8000	Harris HM6100 Page 966	Harris HM6100A Page 966
General Structure	16-Bit CPU	8-Bit CPU	12-Bit CPU	12-Bit CPU
Type	NMOS	PMOS	CMOS	CMOS
No. of Devices per CPU	1	1	1	1
CPU Size (Pins)	40	40	40	40
Supply Voltage	-3, 5, 12	-12, 5	5	4-11
CPU Power Dissipation (mw)	750	500	10	40
Architecture Data Word Size (bits)	16	8	12	12
Instruction Word Size (bits)	10, 20, 30	8, 16, 24	12	12
Directly Addressable Instruction Words (No.)	65K	65K	4K (Expandable to 32K)	4K (Expandable to 32K)
Clock Frequency (Hz/ext. phases required)	5 MHz/2 phase	800 KHz/1 phase	4 MHz/0 phase	8 MHz/0 phase
Register to Register Add Time (μsec/data word)	2.4	5.0	5 (2.50 10V)	2.5
No. of Registers Arithmetic	0	1	2	2
Index	0	0	0	0
General Purpose	8	48	4	4
Return Stack Size (No. x bits)	Standard	1x8 or RAM	None	None
Interrupts	External RAM	Standard	Standard	Standard
Type	Vectored, Multilevel	Vectored, 1 Level	Vectored, 1 Level	Vectored, 1 Level
Direct Memory access	Standard	No	Standard	Standard
BCD Arithmetic (Hardware)	No	Yes	No	No
Microprogrammable	No	No	No	No
Extended Temp. Range Available			-55°C to 125°C	-55°C to 125°C
Devices See System Components:	1600	8000	6100	6100
Hardware Support Processor Cards (CPU system on a card)	Yes	Yes	Yes	Yes
Prototyping System (Hardware and software development system)	Yes	Yes	Yes	Yes
In-System Emulator (Tests system in place)	Yes	No	No	No
Software Support (from this manufacturer) Resident Assembler	Yes	Yes	Yes	Yes
Cross Assembler	Fortran IV	Fortran IV	Fortran IV	Fortran IV
Simulator	Fortran IV	Fortran IV	Fopel III	Fopel
High Level Language	No	No	Focal, Basic, Fortran	Focal, Basic, Fortran
Programs Debug	Yes	Yes	Yes	Yes
Diagnostic	Yes	Yes	Yes	Yes
Edit	Yes	Yes	Yes	Yes
User Library (>25 programs from user)	No	No		
Delivery Start (Qtr.-Year)	3 Qtr. 74	2 Qtr. 75	1 Qtr. 76	1 Qtr. 76
Alternate Sources	EMM/SEMI	None	Intersil	Intersil
Comments	CP-1600 3.6 μsec add time with 3.3 MHz clock		Processor executed programs written for the PDP8E (DEC minicomputer)	Processor executes programs written for the PDP8E (DEC minicomputer)

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MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	Intel 3000	Intel 4004	Intel 4040	Intel 8008
General Structure	2-Bit Slice	4-Bit CPU	4-Bit CPU	8-Bit CPU
Type	TTL	PMOS	PMOS	PMOS
No. of Devices per CPU	≥2	1	1	1
CPU Size (Pins)	28 and 40	16	24	18
Supply Voltage	5	15 (or -10.5)	15 (or -10.5)	-9.5
CPU Power Dissipation (mw)	800	450	1000	420
Architecture				
Data Word Size (bits)	Multiple of 2	4	4	8
Instruction Word Size (bits)		8, 16	8, 16	8, 16, 24
Directly Addressable Instruction Words (No.)	512 (Microinstructions)	4K	4K	16K
Clock Frequency (Hz/ext. phases required)	to 6 MHz/1 phase	500 to 740 kHz/2 phase	500 to 740 kHz/2 phase	800 kHz/2 phase
Register to Register Add Time (μsec/data word)	0.15 (16 bits)	10.8	10.8	12.5
No. of Registers				
Arithmetic	2	1	1	1
Index	0	0	0	0
General Purpose	11	16	24	6
Return Stack Size (No. x bits)	None	3x12	7x12	7x14
Interrupts	Optional	None	Standard	Standard
Type	8 Level Priority (3214)		Vectored, 1 Level	Vectored, 8 Level
Direct Memory Access	No	None	None	Optional (8257)
BCD Arithmetic (Hardware)	No	Yes	Yes	No
Microprogrammable	Yes	No	No	No
Extended Temp. Range Available	-55° C to 125° C	-40° C to 85° C	-55° C to 85° C	-55° C to 85° C
Devices				
See System Components:	3000	4004/4040	4004/4040	8008
Hardware Support				
Processor Cards (CPU system on a card)	No	Yes	Yes	Yes
Prototyping System (Hardware and software development system)	Yes	Yes	Yes	Yes
In-System Emulator (Tests system in place)	Yes	No	No	No
Software Support				
(from this manufacturer) Resident Assembler	No	Yes	Yes	Yes
Cross Assembler	CROMIS Microassembler	Fortran IV	Fortran IV	Fortran IV
Simulator	No	Fortran IV	Fortran IV	Fortran IV
High Level Language	No	No	No	PL/M (Fortran IV)
Programs				
Debug	No	Yes	Yes	Yes
Diagnostic	No	Yes	Yes	Yes
Edit	No	Yes	Yes	Yes
User Library (>25 programs from user)	No	Yes	Yes	Yes
Delivery Start (Qtr.-Year	3 Qtr. 74	2 Qtr. 71	4 Qtr. 74	1 Qtr. 72
Alternate Sources	Signetics	National	None	None
Comments				8 level interrupts with 8214 Priority Interrupt IC.

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MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	Intel 8080A	Intersil IM6100	Intersil 2650	Mitsubushi MELPS 8
General Structure	8-Bit CPU	12-Bit CPU	8-Bit CPU	8-Bit CPU
Type	NMOS	CMOS	NMOS	NMOS
No. of Devices per CPU	1	1	1	1
CPU Size (Pins)	40	40	40	40
Supply Voltage	±5, 12	5 to 10 (5 nominal)	5	±5, 12
CPU Power Dissipation (mw)	780	10	500	780
Architecture				
Data Word Size (bits)	8	12	8	8
Instruction Word Size (bits)	8, 16, 24	12	8, 16, 24	8, 16, 24
Directly Addressable Instruction Words (No.)	65K	4K (Expandable to 32K)	32K	65K
Clock Frequency (Hz/ext. phases required)	2 MHz/2 phase (2.6 and 3 MHz opt.)	4 MHz/0 phase	0 to 1.25 MHz/1 phase	2 MHz/2 phase
Register to Register Add Time (μsec/data word)	2 (2 MHz clock)	5 (2.5 at 10V)	4.8	2 (2 MHz clock)
No. of Registers				
Arithmetic	1	2	0	1
Index	0	0	0	0
General Purpose	6	4	7	6
Return Stack Size (No. x bits)	External RAM	None	8x15	External RAM
Interrupts	Standard	Standard	Standard	Standard
Type	Vectored, Multilevel	Vectored, 1 Level	Vectored	
Direct Memory Access	Standard	Standard	Standard	Standard
BCD Arithmetic (Hardware)	Yes	No	Standard	Yes
Microprogrammable	No	No	No	No
Extended Temp. Range Available	-55°C to 125°C	-55°C to 125°C	No	No
Devices				
See System Components:	8080	6100	2650	8080
Hardware Support				
Processor Cards (CPU system on a card)	Yes	Yes	Yes	
Prototyping System (Hardware and software development system)	Yes	Yes	Future	
In-System Emulator (Tests system in place)	Yes	No	Future	
Software Support (from this manufacturer)				
Resident Assembler	Yes	Yes	Yes	Yes
Cross Assembler	Fortran IV	Yes	Fortran VI PDP-11	Yes
Simulator	Fortran IV	Forpal III	Fortran IV	
High Level Language	PL/M (Fortran IV)	Yes	No	PL/M
Programs				
Debug	Yes	Yes	Yes	
Diagnostic	Yes	Yes	Yes	
Edit	Yes	Yes	Yes	
User Library (>25 programs from user)	Yes	Yes (DEC)	No	
Delivery Start (Qtr.-Year)	4 Qtr. 73	2 Qtr. 75	2 Qtr. 76	
Alternate Sources	AMD, National, NEC, TI	Harris	Signetics	
Comments		Executive PDP-8, Instruction Set	Any of the registers can be used as an index register.	CPU M58710S compatible with 8080

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MICROPROCESSORS (Cont'd)

Manufacturer Model For detailed Data See:	Monolithic Memories 67000	MOS Technology 6500	Mostek F8	Mostek MK3870
General Structure	4-Bit Slice	8-Bit CPU	8-Bit CPU	8-Bit CPU
Type	TTL	NMOS	NMOS	NMOS
No. of Devices per CPU		1	1	1
CPU Size (Pins)	40	40 or 28	40	40
Supply Voltage	5	5	5, 12	5
CPU Power Dissipation (mw)	900	200	600	300
Architecture				
Data Word Size (bits)	Multiple of 4	8	8	8
Instruction Word Size (bits)	8	8, 16, 24	8, 16, 24	8, 16, 24
Directly Addressable Instruction Words (No.)		65K	65K	2K
Clock Frequency (Hz/ext. phases required)	0 to 15 MHz/1 phase (67001) 0 to 10 MHz/1 phase (6701)	to 2 MHz/1 phase	2 MHz/0 phase	4 MHz
Register to Register Add Time (μsec/data word)	0.05 typ. (67001) 0.085 typ. (6701)	1	2	2
No. of Registers Arithmetic	0	1	1	1
Index	0	2	2	2
General Purpose	17	0	65	65
Return Stack Size (No. x bits)	1x8 (67110)	External RAM	1x8 or RAM	1x8 or RAM
Interrupts	67116	Standard	Standard	Standard
Type	16 Vectored	Vectored, 2 Level	Vectored, 1 Level/PSU	Vectored, 1 Level
Direct Memory Access	No	Optional	Optional (MK3854)	None
BCD Arithmetic (Hardware)	No	Yes	Yes	Yes
Microprogrammable	Yes	No	No	No
Extended Temp. Range Available	-55°C to 125°C	-55°C to 85°C		-40°C to 85°C
Devices See System Components:	67000	6500	F8	F8
Hardware Support Processor Cards (CPU system on a card)	No	Yes	Yes	Yes
Prototyping System (Hardware and software development system)	No	Yes	Yes	Yes
In-System Emulator (Tests system in place)	No	Yes	Yes	Yes
Software Support (from this manufacturer) Resident Assembler	No	Yes	Yes	Yes
Cross Assembler	Fortran IV	Fortran IV	Fortran IV	Fortran IV
Simulator	No	Fortran IV	Timesharing	No
High Level Language	No	No	No	No
Programs Debug	No	Yes	Yes	Yes
Diagnostic	No	Yes	Yes	Yes
Edit	No	No	Yes	Yes
User Library (>25 programs from user)	No	No	No	No
Delivery Start (Qtr.-Year)	4 Qtr. 75	3 Qtr. 75	3 Qtr. 75	1 Qtr. 77
Alternate Sources		Synertek	Fairchild	
Comments	RAM on-chip.	DMA based on a stopping CPU. But address bus connections are not 3 state.	64 bytes of RAM in CPU. 1024 bytes of ROM in PSU, programmable timer.	One chip F8 microcomputer. Programmable hardware, timer on-chip.

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MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	Mostek Z80	Motorola M2901	Motorola M6800	Motorola M10800
General Structure	8-Bit CPU	4-Bit Slice	8-Bit CPU	4-Bit Slice
Type	NMOS	TTL	NMOS	ECL
No. of Devices per CPU	1		1	
CPU Size (Pins)	40	40	40	48
Supply Voltage	5	5	5	-2, -5.2
CPU Power Dissipation (mw)	1100	925	600	
Architecture				
Data Word Size (bits)	8	Multiple of 4	8	Multiple of 4
Instruction Word Size (bits)	8, 16, 24, 36	9	8, 16, 24	
Directly Addressable Instruction Words (No.)	65K		65K	
Clock Frequency (Hz/ext. phases required)	2.5 MHz/2 phase (4 MHz opt.)	to 10 MHz/1 phase	1 MHz/2 phase	0 to 6 MHz/1 phase
Register to Register Add Time (μsec/data word)	1.6 (2.5 MHz dock)	0.125	2	0.041 typ. 16-Bit
No. of Registers				
Arithmetic	1	0	2	Ext.
Index	2	0	1 (16-Bit)	MC10803
General Purpose	14	17	0	MC10803
Return Stack Size (No. x bits)	External RAM	4x4 (M2909)	External RAM	MC10801
Interrupts	Standard	Optional	Standard	
Type	Vectored, Multilevel		Vectored, Multilevel	
Direct Memory Access	MK3883-DMA	Optional	Optional	
BCD Arithmetic (Hardware)	Yes	No	Yes	Yes
Microprogrammable	No	Yes	No	Yes
Extended Temp. Range Available	-55°C to 125°C		No	No
Devices				
See System Components:	Z80	2900	6800	10800
Hardware Support				
Processor Cards (CPU system on a card)	Yes	No	Yes	No
Prototyping System (Hardware and software development system)	Yes	No	Yes	No
In-System Emulator (Tests system in place)	Yes	No	Yes	No
Software Support (from this manufacturer)				
Resident Assembler	Yes	No	Yes	No
Cross Assembler	Fortran IV	No	Fortran IV	No
Simulator	Timesharing	No	Fortran IV	No
High Level Language	PLZ	No	MPL (Fortran)	No
Programs				
Debug	Yes	No	Yes	No
Diagnostic	Yes	No	Yes	No
Edit	Yes	No	Yes	No
User Library (>25 programs from user)	No	No	No	No
Delivery Start (Qtr.-Year)	2 Qtr. 76	3 Qtr. 76	2 Qtr. 74	2 Qtr. 76
Alternate Sources	Zilog	AMD, Raytheon	AMI, Fairchild, Hitachi	Future
Comments	8080A Software compatible with additional instructions Vectored priority interrupt in peripheral devices.		DMA through HALT and three state control.	

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MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	National DP8080A Page 1033	National IMP 16 Pages 986, 1043	National INS4004 (FIPS) Pages 986, 1059	National IPC-16 (PACE) Pages 986, 1022, 1077
General Structure	8-Bit CPU	4-Bit Slice	4-Bit CPU	16-Bit CPU
Type	NMOS	PMOS	PMOS	PMOS
No. of Devices per CPU	1		1	1
CPU Size (Pins)	40	24	16	40
Supply Voltage	±5, 12	-12, 5	15 (or -10, 5)	-12, 5
CPU Power Dissipation (mw)	780		450	700
Architecture Data Word Size (bits)	8	16	4	8 or 16
Instruction Word Size (bits)	8, 16, 24	16	8, 16	16
Directly Addressable Instruction Words (No.)	65K	65K	4K	65K
Clock Frequency (Hz/ext. phases required)	2 MHz/2 phase (3 MHz opt.)	to 700 kHz/4 phase	500 to 740 kHz/2 phase	2 MHz/2 phase
Register to Register Add Time (μsec/data word)		4.6	10.8	8
No. of Registers Arithmetic	1	4	1	1
Index	0	4	0	3
General Purpose	6	4	16	0
Return Stack Size (No. x bits)	External RAM	16x16	3x12	10x16
Interrupts	Standard	Standard	None	Standard
Type	Vectored, Multilevel	2 Level		Vectored, 6 Level
Direct Memory Access	Standard	Optional	None	Optional
BCD Arithmetic (Hardware)	Yes	No	Yes	Standard
Microprogrammable	No	Yes	No	No
Extended Temp. Range Available	No	No		-55°C to 85°C
Devices See System Components:	8080	IMP	4004/4040	PACE
Hardware Support Processor Cards (CPU system on a card)	Yes	Yes	No	Yes
Prototyping System (Hardware and software development system)	Yes	Yes	No	Yes
In-System Emulator (Tests system in place)		No	No	No
Software Support (from this manufacturer) Resident Assembler	Yes	Yes	No	Yes
Cross Assembler		Fortran IV	No	Fortran IV
Simulator		No	No	No
High Level Language		SM/PL	No	Basic
Programs Debug	Yes	Yes	No	Yes
Diagnostic	Yes	Yes	No	Yes
Edit	Yes	Yes	No	Yes
User Library (>25 programs from user)	No	Yes	No	Yes
Delivery Start (Qtr.-Year)	3 Qtr. 76	1 Qtr. 73	3 Qtr. 75	2 Qtr. 75
Alternate Sources	AMD, Intel, NEC, TI	None	Intel	None
Comments	Hardware and software support thru independent company.	DMA requires external controller.		DMA requires external controller.

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MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	National ISP-8A(SC/MP) Pages 986, 998, 1077	National MM5781/82	National MM5799	NEC PD8080A
General Structure	8-Bit CPU	4-Bit CPU	4-Bit CPU	8-Bit CPU
Type	NMOS	PMOS	PMOS	NMOS
No. of Devices per CPU	1	1	1	1
CPU Size (Pins)	40	28	28	40
Supply Voltage	5	8.5	8.5	±5, 12
CPU Power Dissipation (mw)	420	150	150	780
Architecture Data Word Size (bits)	8	4	4	8
Instruction Word Size (bits)	8, 16	8	8	8, 16, 24
Directly Addressable Instruction Words (No.)	65K	2K to 16K	1536 (internal)	65K
Clock Frequency (Hz/ext, phases required)	4 MHz/0 phase	400 kHz/10 phase	400 kHz/0 phase	2 MHz/2 phase (1.25 to 3 MHz Opt.)
Register to Register Add Time (μsec/data word)	7	10	10	2 (2 MHz clock)
No. of Registers Arithmetic	1	0	0	1
Index	4	0	0	0
General Purpose	0	3	3	6
Return Stack Size (No. x bits)	Software Stack	2x11	2x11	External RAM
Interrupts	Standard	Standard	None	Standard
Type	Vectored	1 Level		Vectored, Multilevel
Direct Memory Access	Standard	None	None	Standard
BCD Arithmetic (Hardware)	Standard	Yes	Yes	Yes
Microprogrammable	No	No	No	No
Extended Temp. Range Available	-55°C to 85°C			No
Devices See System Components:	SCMP	5781/82	5799	8080
Hardware Support Processor Cards (CPU system on a card)	Yes	Yes	No	Yes
Prototyping System (Hardware and software development system)	Yes	Yes	Yes	Yes
In-System Emulator (Tests system in place)	No	Yes	No	No
Software Support (from this manufacturer) Resident Assembler	Yes	No	No	Yes
Cross Assembler	Fortran IV, Timesharing	Yes	Yes	Timesharing
Simulator	Yes	Yes	Timesharing	
High Level Language	Tiny Basic	No	No	PL/N
Programs Debug	Yes	Yes	Yes	Yes
Diagnostic	Yes	Yes	Yes	Yes
Edit	Yes	Yes	Yes	Yes
User Library (>25 programs from user)	Yes	No	No	No
Delivery Start (Qtr.-Year)	1 Qtr. 76	4 Qtr. 75	2 Qtr. 76	3 Qtr. 75
Alternate Sources		None	None	AMD, National, TI
Comments		2 chip calculator based system, expandable RAM, ROM, I/O	1 chip calculator based system, expandable RAM, I/O	NEC μPD753 is 42 pin version

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MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	Raytheon Semi 2900	RCA CDP1800 (COSMAC)	RCA CDP1802	Rockwell PPS-4/1
General Structure	4-Bit Slice	8-Bit CPU	8-Bit CPU	4-Bit CPU
Type	TTL	CMOS	CMOS	PMOS
No. of Devices per CPU		2	1	1
CPU Size (Pins)	40	28 or 40	40	42
Supply Voltage	5	3 to 12/4 to 6	4 to 6/3 to 12	15
CPU Power Dissipation (mw)	925	60	6 to 40	200
Architecture Data Word Size (bits)	Multiple of 4	8	8	4
Instruction Word Size (bits)	9	8	8, 16, 24	8, 16
Directly Addressable Instruction Words (No.)		65K	65K	
Clock Frequency (Hz/ext. phases required)	to 10 MHz/1 phase	0 to 4 MHz/1 phase	0-6.4 MHz/0 phase	
Register to Register Add Time (μsec/data word)	0.125	6 (2.7 MHz clock)	2.5 (6.4 MHz clock)	
No. of Registers Arithmetic	0	1	1	1
Index	0	0	0	0
General Purpose	17	32	32	1
Return Stack Size (No. x bits)	4x4 (2909)	External RAM	External RAM	
Interrupts	Optional	Standard	Standard	
Type		1 Level	1 Level	
Direct Memory Access	Optional	Standard (on-chip)	Standard (on-chip)	
BCD Arithmetic (Hardware)	No	No	No	No
Microprogrammable	Yes	No	No	No
Extended Temp. Range Available	-55 C to 125 C	-55 C to 125 C Standard	-55 C to 125 C Standard	
Devices See System Components:	2900	1800	1800	PPS-4, PPS-8
Hardware Support Processor Cards (CPU system on a card)	No	No	Yes	
Prototyping System (Hardware and software development system)	No	Yes	Yes	Yes
In-System Emulator (Tests system in place)	No	No	No	Yes
Software Support (from this manufacturer) Resident Assembler	No	Yes	Yes	Yes
Cross Assembler	No	Fortran IV, Timesharing	Fortran IV, Timesharing	
Simulator	No	Yes	Yes	Yes
High Level Language	No	No	No	No
Programs Debug	No	Yes	Yes	Yes
Diagnostic	No	Yes	Yes	Yes
Edit	No	Yes	Yes	Yes
User Library (>25 programs from user)	No	No	No	
Delivery Start (Qtr.-Year)	1 Qtr. 76	1 Qtr. 75	1 Qtr. 76	2 Qtr. 76
Alternate Sources	AMD, Motorola	None	Hughes	
Comments	Microassembler on timeshare.	DMA address pointer and control logic on chip.	Software upward compat. with CDP1801.	1-chip parallel microcomputer, several memory options.

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MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	Rockwell PPS-4/2, PPS-4	Rockwell PPS-8	Scientific Microsystems SM300	Signetics N3000
General Structure	4-Bit CPU	8-Bit CPU	8-Bit CPU	2-Bit Slice
Type	PMOS	PMOS	TTL	TTL
No. of Devices per CPU	1	1	1	
CPU Size (Pins)	42	42	50	28 and 40
Supply Voltage	17 (or -12, 5)	17 (or -12, 5)	5	5
CPU Power Dissipation (mw)	225	225	2000	800
Architecture Data Word Size (bits)	4	8	8	Multiple of 2
Instruction Word Size (bits)	8, 16 (Multifunction instr.)	8, 16, 24 (Multifunction instr.)	16	≥18
Directly Addressable Instruction Words (No.)	4K	16K	8K	512
Clock Frequency (Hz/ext. phases required)	(PPS-4) 256 kHz/2 phase (PPS-4/2) 199 kHz/0 or 2 phase	(PPS-8/2) 189 kHz/0 phase (PPS-8) 256 kHz/2 phase	8 MHz/phase	to 6 MHz/1 phase
Register to Register Add Time (μsec/data word)	5	(PPS-8/2) 5 (PPS-8) 4	0.25	
No. of Registers Arithmetic	0	1		2
Index	0	0		0
General Purpose	3	6	8	10
Return Stack Size (No. x bits)	2x12	32x8		None
Interrupts	Standard PPS-4	Standard	Yes	Optional
Type	1 Level	3 Level	Polled	8 Level Priority
Direct Memory Access	None	Optional DMA Controller	Yes	No
BCD Arithmetic (Hardware)	No	No	No	No
Microprogrammable	No	No	No	Yes
Extended Temp. Range Available	-55°C to 125°C	-55°C to 125°C		No
Devices See System Components:	PPS-4, PPS-8	PPS-4, PPS-8	8X300	3000
Hardware Support Processor Cards (CPU system on a card)	Yes	Yes	Yes	No
Prototyping System (Hardware and software development system)	Yes	Yes	Yes	No
In-System Emulator (Tests system in place)	Yes	Yes	Yes	No
Software Support (from this manufacturer) Resident Assembler	Yes	Yes	No	No
Cross Assembler	Fortran IV, Timesharing	Fortran IV, Timesharing	Yes	No
Simulator	Yes	Yes		No
High Level Language	No	No	No	No
Programs Debug	Yes	Yes	No	No
Diagnostic	Yes	Yes	Yes	No
Edit	Yes	Yes		No
User Library (>25 programs from user)	Yes	No	No	No
Delivery Start (Qtr.-Year)	PPS-4 3 Qtr. 72, PPS-4/2 3 Qtr. 75	PPS-8 1 Qtr. 75, PPS-8/2 2 Qtr. 76	2 Qtr. 75	3 Qtr. 75
Alternate Sources			Signetics	Intel
Comments	The PPS-4/2 is a 2 chip clock, direct display drive, expanded I/O on CPU chip; 128-4 RAM, 2048x8 ROM, 16 I/O ports on separate memory-I/O chip.			Uses 74S182 for Look-Ahead Carry.

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MICROPROCESSORS (Cont'd)

Manufacturer **Model** **For Detailed Data See:**	Signetics 8X300	Signetics 2650	Synertek SY6500	Texas Instruments SBP0400 Page 1102
General Structure	8-Bit CPU	8-Bit CPU	8-Bit CPU	4-Bit Slice
Type	TTL	NMOS	NMOS	I²L
No. of Devices per CPU	1	1	1	
CPU Size (Pins)	50	40	40 or 28	40
Supply Voltage	5	5	5	200 mA at 0.85V
CPU Power Dissipation (mw)	2000	525	200	170
Architecture Data Word Size (bits)	8	8	8	9 (Microinstruction Select)
Instruction Word Size (bits)	16	8, 16, 24	8, 16, 24	
Directly Addressable Instruction Words (No.)	8K	32K	65K	(512 Microinstructions)
Clock Frequency (Hz/ext. phases required)	8 MHz/phase	0 to 1.25 MHz/1 phase	to 2 MHz/1 phase	to 2 MHz/1 phase
Register to Register Add Time (μsec/data word)	0.25	4.8	1	0.5 (2 MHz clock)
No. of Registers Arithmetic		0	1	2
Index		0	2	0
General Purpose	8	7	0	8
Return Stack Size (No. x bits)		8x15	External RAM	None
Interrupts	Yes	Standard	Standard	Optional
Type	Polled	Vectored	Vectored, 2 Level	Optional
Direct Memory Access	Yes	Standard	Optional	Standard
BCD Arithmetic (Hardware)	No	Standard	Yes	Microprogrammable
Microprogrammable	No	No	No	(512 Microinstructions)
Extended Temp. Range Available	Future	No	-55°C to 85°C	-55°C to 125°C
Devices See System Components:	8X300	2650	6500	SBP400
Hardware Support Processor Cards (CPU system on a card)	Yes	Yes	Yes	No
Prototyping System (Hardware and software development system)	Yes	Yes	Yes	Yes (hardware)
In-System Emulator (Tests system in place)	Yes	Yes	Yes	No
Software Support (from this manufacturer) Resident Assembler	No	Yes	Yes	No
Cross Assembler	Yes	Fortran IV, PDP-11	Fortran IV	Fortran microassembler
Simulator		Fortran IV	Fortran IV	No
High Level Language	No	PL/μS	No	No
Programs Debug	No	Yes	Yes	No
Diagnostic	Yes	Yes	Yes	No
Edit		Yes	No	No
User Library (>25 programs from user)	No	No	No	No
Delivery Start (Qtr.-Year)	3 Qtr. 76	2 Qtr. 75	4 Qtr. 75	1 Qtr. 75
Alternate Sources	Scientific Microsystems	Intersil	MOS Technology	None
Comments	Bipolar with fixed instructions.	Any of the general purpose registers can be used as an index register.	DMA based on a stopping CPU, but address bus connections are not 3 state.	Current drain can be set from 0.001 to 200 mA.

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MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	Texas Instruments TMS1000/1200 Page 1090	Texas Instruments TSM1070/1270 Page 1090	Texas Instruments TMS1100/1300 Page 1090	Texas Instruments TMS8080 Page 1097
General Structure	4-Bit Microcomputer	4-Bit Microcomputer	4-Bit Microcomputer	8-Bit CPU
Type	PMOS	PMOS	PMOS	NMOS
No. of Devices per CPU	1	1	1	1
CPU Size (Pins)	28 or 40	28 or 40	28 or 40	40
Supply Voltage	15	15	15	±5, 12
CPU Power Dissipation (mw)	90	100	90	1500
Architecture Data Word Size (bits)	4	4	4	8
Instruction Word Size (bits)	8	8	8	8, 16, 24
Directly Addressable Instruction Words (No.)	1K	1K	2K	65K
Clock Frequency (Hz/ext. phases required)	300 kHz/0 phase	300 kHz/0 phase	300 kHz/0 phase	2 MHz/2 phase
Register to Register Add Time (μsec/data word)	34 (350 kHz clock)	34 (350 kHz clock)	34 (350 kHz clock)	2
No. of Registers Arithmetic	1	1	1	1
Index	0	0	0	0
General Purpose	1	1	1	6
Return Stack Size (No. x bits)	1x10	1x10	1x10	External RAM
Interrupts	None	None	None	Standard
Type				Vectored, 8 Level
Direct Memory Access	None	None	None	Standard
BCD Arithmetic (Hardware)	Microprogrammable	Microprogrammable	Microprogrammable	Yes
Microprogrammable	Yes	Yes	Yes	No
Extended Temp. Range Available		Yes	Yes	No
Devices See System Components:	1000	1000	1000	8080
Hardware Support Processor Cards (CPU system on a card)	No	No	No	No
Prototyping System (Hardware and software development system)	Yes	Yes	Yes	No
In-System Emulator (Tests system in place)	Yes	No	Yes	No
Software Support (from this manufacturer) Resident Assembler	Yes	Yes	Yes	No
Cross Assembler	Timesharing	Yes	Yes	Timesharing
Simulator	Timesharing	Yes	Yes	Timesharing
High Level Language	No	No	No	No
Programs Debug	Yes	Yes	Yes	Yes
Diagnostic	Yes	Yes	Yes	Yes
Edit	Yes	Yes	Yes	Yes
User Library (>25 programs from user)				No
Delivery Start (Qtr.-Year)	1 Qtr. 75	4 Qtr. 75	4 Qtr. 75	2 Qtr. 75
Alternate Sources	None	None	None	AMD, Intel, Nat'l, NEC
Comments	A 64 pin version, TMS1099/SE-1, permits use of external PROM, RAM or ROM for program development.	35V output drive capability	A 64-pin version, TMS1098/SE-2 permits use of external PROM/RAM/ROM for program development.	

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MICROPROCESSORS (Cont'd)

Manufacturer Model For Detailed Data See:	Texas Instruments TMS9900 Page 1092	Texas Instruments TMS9980 Page 1092	Toshiba TLCS-12A	Western Digital MP1600
General Structure	16-Bit CPU	8/16-Bit CPU	12-Bit CPU	16-Bit CPU
Type	NMOS	NMOS	PMOS	NMOS
No. of Devices per CPU	1	1	1	3
CPU Size (Pins)	64	40	36	40/device
Supply Voltage	±5, 12	±5, 12	±5	±5, 12
CPU Power Dissipation (mw)	1000	1000	800	600
Architecture				
Data Word Size (bits)	16	8	12	16
Instruction Word Size (bits)	16, 32, 48	16, 32, 48	12, 24	16
Directly Addressable Instruction Words (No.)	65K bytes/32K words	16K bytes	4K	65K
Clock Frequency (Hz/ext. phases required)	3 MHz/4 phase	2-3 MHz/phase	1.2 MHz/0 phase	3.3 MHz/4 phase
Register to Register Add Time (μsec/data word)	4.67	8.8 (2 MHz)	13	2.7
No. of Registers Arithmetic	16	16	0	4
Index	15	15	0	2
General Purpose	16 (in memory)	16 (in memory)	7	2
Return Stack Size (No. x bits)	None	None		External RAM
Interrupts	Standard	Standard	Yes	Standard
Type	Vectored, 16 Level	Vectored, 6 Level		Vectored
Direct Memory Access	Standard	Standard	Optional	Standard
BCD Arithmetic (Hardware)	No	No	No	Standard
Microprogrammable	No	No	No	Yes
Extended Temp. Range Available	-25°C to 85°C			No
Devices See System Components:	9900	9900	TLCS-12	1600
Hardware Support Processor Cards (CPU system on a card)	Yes 990/4	No	No	Yes
Prototyping System (Hardware and software development system)	Yes	Yes	Yes	Yes
In-System Emulator (Tests system in place)	No	No	No	No
Software Support (from this manufacturer) Resident Assembler	Yes	Yes		Yes
Cross Assembler	Yes	Timesharing	Yes	No
Simulator	Timesharing	Timesharing	Yes	No
High Level Language	Fortran, Cobol	Fortran, Cobol	Yes	No
Programs Debug	Yes	Yes	Yes	Yes
Diagnostic	Yes	Yes	Yes	Yes
Edit	Yes	Yes	Yes	Yes
User Library (>25 programs from user)	Yes	Yes	Yes	No
Delivery Start (Qtr.-Year)	2 Qtr. 76	4 Qtr. 76	2 Qtr. 74	1 Qtr. 75
Alternate Sources	None	None	None	None
Comments	Instructions include hardware multiply and divide and are software compatible with 990 minicomputers.	8-Bit data bus, 16-Bit internal op. Software compatible TMS9900.		

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MICROPROCESSORS (Cont'd)

Manufacturer **Model** **For Detailed Data See:**	Western Digital MCP1600	Zilog Z80
General Structure	8-Bit CPU	8-Bit CPU
Type	NMOS	NMOS
No. of Devices per CPU	3	1
CPU Size (Pins)	40/device	40
Supply Voltage	±5, 12	5
CPU Power Dissipation (mw)	600	1100
Architecture		
Data Word Size (bits)	8 or 16	8, 16
Instruction Word Size (bits)	16	8, 16, 24, 32
Directly Addressable Instruction Words (No.)	65K (84 Microinstructions)	65K
Clock Frequency (Hz/ext. phases required)	3.3 MHz/4 phase	2.5 MHz/1 phase (4 MHz opt.)
Register to Register Add Time (μsec/data word)	0.3 (8-Bit), 0.6 (16-Bit)	1.6 (2.5 MHz clock)
No. of Registers		
Arithmetic	0	1
Index	0	2
General Purpose	26	14
Return Stack Size (No. x bits)	External RAM	External RAM
Interrupts	Standard	380-DMA
Type	Vectored, 4 Level	Vectored, Multilevel
Direct Memory Access	Standard	Standard
BCD Arithmetic (Hardware)	Microprogrammable	Yes
Microprogrammable	Yes	No
Extended Temp. Range Available	No	-55°C to 125°C (Zilog)
Devices		
See System Components:	1600	Z80
Hardware Support		
Processor Cards (CPU system on a card)	Yes	Yes
Prototyping System (Hardware and software development system)	Yes	Yes
In-System Emulator (Tests system in place)	Yes	Yes
Software Support (from this manufacturer)		
Resident Assembler	No	Yes
Cross Assembler	Timesharing, PDP-11	Fortran IV
Simulator	Timesharing, PDP-11	Timesharing
High Level Language	No	PL/Z
Programs		
Debug	Yes	Yes
Diagnostic	Yes	Yes
Edit	Yes	Yes
User Library (>25 programs from user)	No	No
Delivery Start (Qtr.-Year)	3 Qtr. 75	1 Qtr. 76
Alternate Sources	None	Mostek
Comments	Can cross assemble and simulate with DEC PDP-11. Microcontroller version avail.	8080A Software compat.

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AMI® 6800

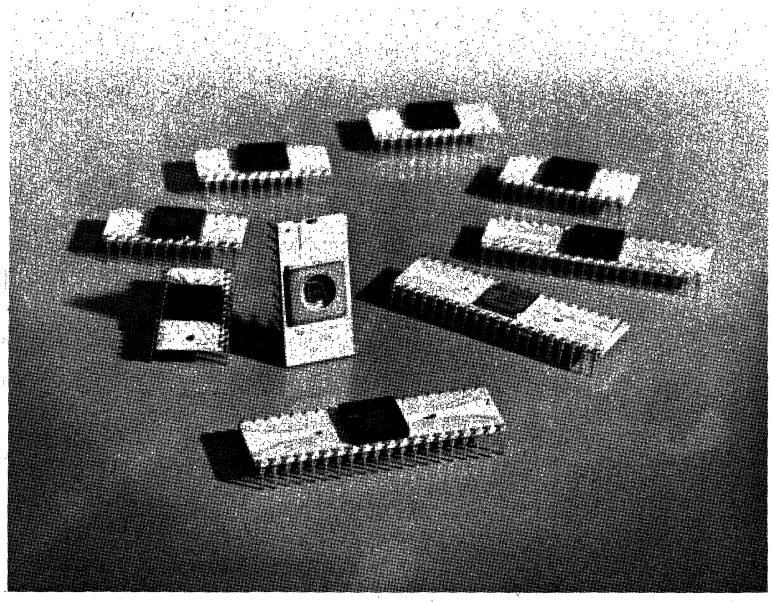
MICROPROCESSORS and SUPPORT CIRCUITS
MICROCOMPUTER DEVELOPMENT CENTER
and other DEVELOPMENT SUPPORT

The AMI 6800 Microcomputer Systems Family

Part No.	Description	Input/Output	Power Supply (V)	Process	Package
S6800	Microprocessor, 8-bit (MPU)	TTL	+5V	N-SiGate	3M, 1T
S6800I*	Microprocessor, 8-bit (MPU)	TTL	+5V	N-SiGate	3M
S6810	RAM, 128 x 8	TTL	+5V	N-SiGate	3L, 2L, 1W
S6810A	RAM, 128 x 8	TTL	+5V	N-SiGate	3L, 2L, 1W
S6830	ROM, 1024 x 8	TTL	+5V	N-SiGate	3L, 2L, 1W
S6831	16,384 Bit Static ROM	TTL	+5V	N-SiGate	3L, 1W
S6834	4096 Bit Static EPROM	TTL	+5, -12	P-SiGate	3L
S6820	Peripheral Interface Adapter (PIA)	TTL	+5V	N-SiGate	3M, 1T
S6820I*	Peripheral Interface Adapter (PIA)	TTL	+5V	N-SiGate	3M 1T
S6850	Asynchronous Communications Interface (ACIA)	TTL	+5V	N-SiGate	3L, 2L, 1W
S2350	Synchronous Receiver/Transmitter (USRT)	TTL	+5V	N-SiGate	3M, 1T
S6860	0-600 BPS Digital Modem	TTL	+5V	N-SiGate	1W, 3L

*Industrial Temperature Range (–40° to +85°C)

Future Products: S6800, S6820, S6850 depletion load versions of above devices–available 1st Quarter 1977; S6852 Serial Synchronous Data Adapter–available 1st Quarter 1977.



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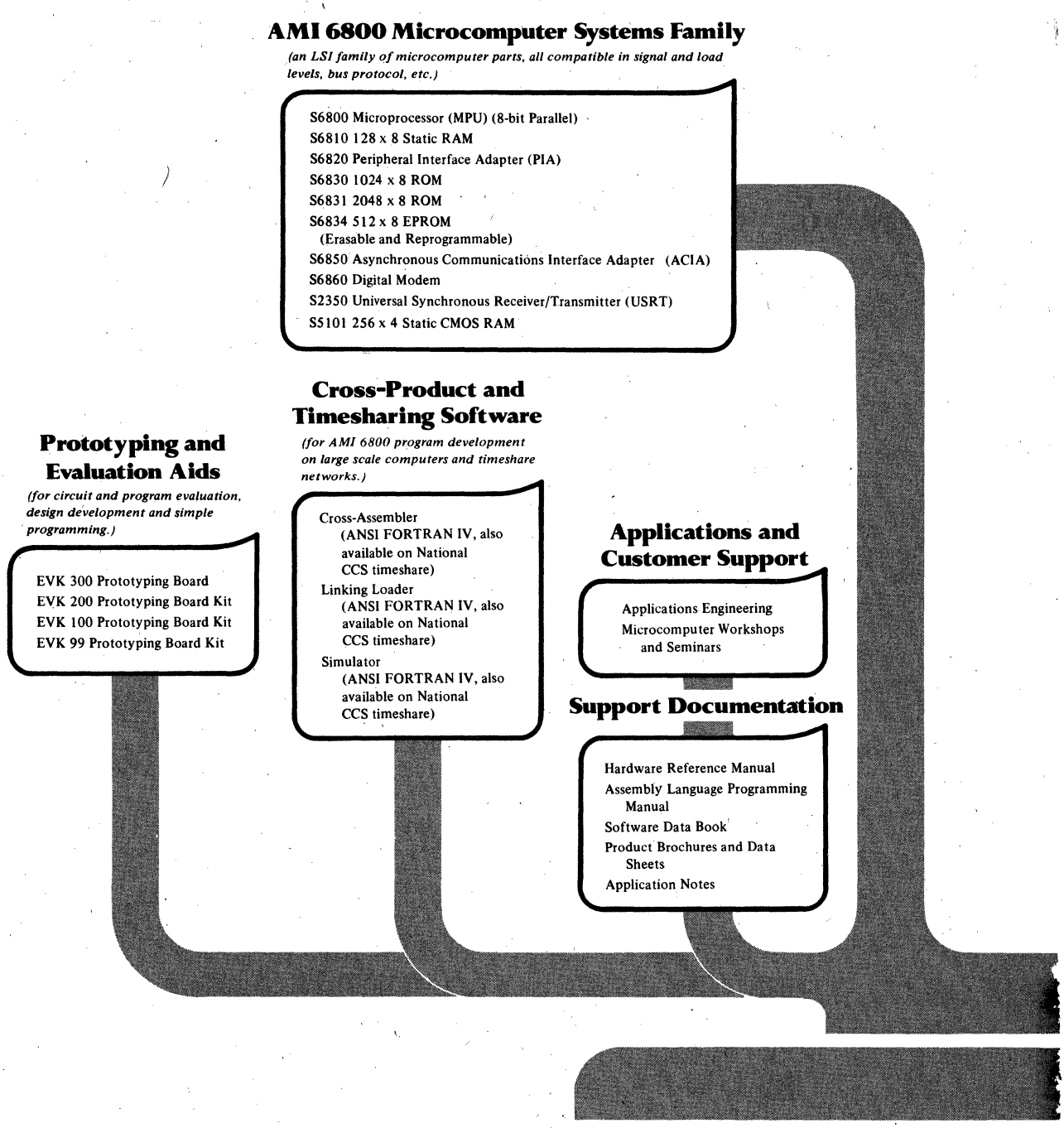
AMI 6800 Microcomputer Hardware and Support Systems



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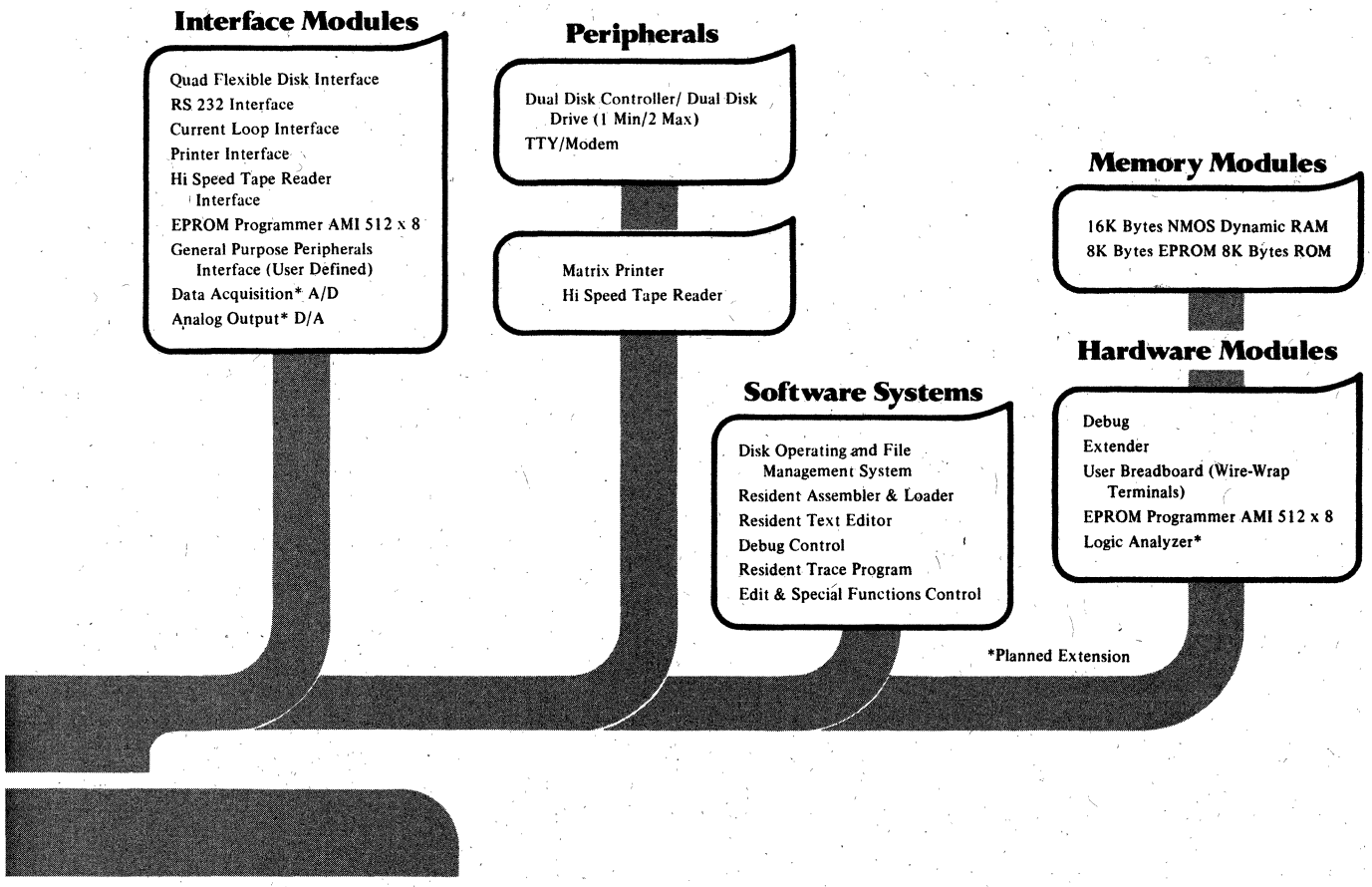
To take full advantage of microcomputers, look to AMI for the superior AMI 6800 family of microcomputer hardware and all the support you need to put it together. AMI offers everything from simple prototyping boards to the resourceful, convenient, and sophisticated Microcomputer Development Center, and some of the most advanced resident and crossproduct software in the industry. AMI offers total support – to make your product design and development task quick, economical, and reliable. It allows you to get your product on the market earlier and thereafter support it better.

Microcomputer Development Center (MDC)

(for complete and effective initial hardware and program development and systems integration; for subsequent product hardware and software expansions, customer support, incoming parts testing, and multiple other uses.)



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AMI 6800 Microcomputer Systems

THE FIRST FAMILY

The AMI S6800 Microcomputer Systems Family is an LSI integrated circuit family for building microcomputers. In its hardware concept it is the same as the SSI and MSI families, except with SSI/MSI each integrated circuit is only an individual logic element (or segment of a larger random logic circuit), whereas in the LSI family each is a whole subsystem of a microcomputer.

By bringing to LSI microcomputer hardware the advantages of the family concept – a series of functionally and electrically matched circuits – the AMI S6800 allows the circuit designer to build complete microcomputer systems of different configurations by simply selecting from the matched subsystem circuits, interconnecting them with the microprocessor into a system, and providing the necessary operating voltages and clock signals. Such a method is superior to choosing an MPU and then matching different memory or I/O circuits to it through interfaces, as must be done with many microprocessor products. The matched LSI family makes the design task simple, fast, and the functional complexity of the system can be increased, while physical size is reduced.

The AMI S6800 Microcomputer Family is a leader in developing this family concept, because S6800 has a wide selection of compatible memory, I/O, and auxiliary circuits, has comprehensive hardware and software support, and wide user acceptance.

COMPLETE AND EASY

The AMI S6800 Microcomputer Family hardware includes the S6800 Microprocessor, a selection of RAM, ROM, and PROM memories, a wide variety of data input/output circuits, and various other support circuits. These components may be assembled in a building block manner into a simple or complex microcomputer system, for many general and special purpose applications. It remains to the user to integrate the microcomputer into his own larger system and to program it for a specific task.

One important design feature of the S6800 family is that within any microcomputer system all components are directly compatible in the system bus and I/O protocol, as well as in individual signal functions, circuit performance characteristics, and logic levels. All operate on a single +5V power supply.

To facilitate system design and programming, AMI provides versatile and easy to use prototyping hardware, various software packages for program generation, an economical CRT/disc system for on-site program generation and debugging, comprehensive hardware and software reference documentation, and other applications support. Such backup is a continuous and expanding effort at AMI.

THE BASIC SYSTEM

A basic S6800 system is shown in Figure 1. In this system the S6800 Microprocessor (MPU) is supported by RAM and ROM (or PROM) memory and controls one input/output circuit. The 1024-byte ROM (or 512-byte eraseable PROM) is used to store the operating program, the 128-byte RAM provides working storage for the MPU, and the Peripheral Interface Adapter (PIA) provides two independently programmable 8-bit input/output ports for communicating with two peripheral devices.

The S6800 system is bus oriented. Eight lines form the data bus and 16 more lines make up the address bus. The MPU controls the bus and all other devices – the memories and the PIA – attach to the bus and wait for instructions from the MPU to supply or receive data. In the system shown in Figure 1, the MPU uses address lines A2, A13, and A14 to select one of the three devices on the bus and uses the Read/Write and Valid Memory Address lines to instruct the devices to receive or send data to the MPU. When communicating with the PIA, address lines A0 and A1 are used to select among the two peripheral devices A and B; the CA1, CA2, CB1, and CB2 lines can be used to send out control signals to the peripherals, or receive service requests.

The basic system is a complete microcomputer, which can be used for a large variety of applications. It is simple but versatile. It can be easily reprogrammed by changing the ROM or using the eraseable PROM instead. The user must provide only the two-phase clock signal source, a power-up/restart circuit, and a single +5V power supply to complete the hardware.

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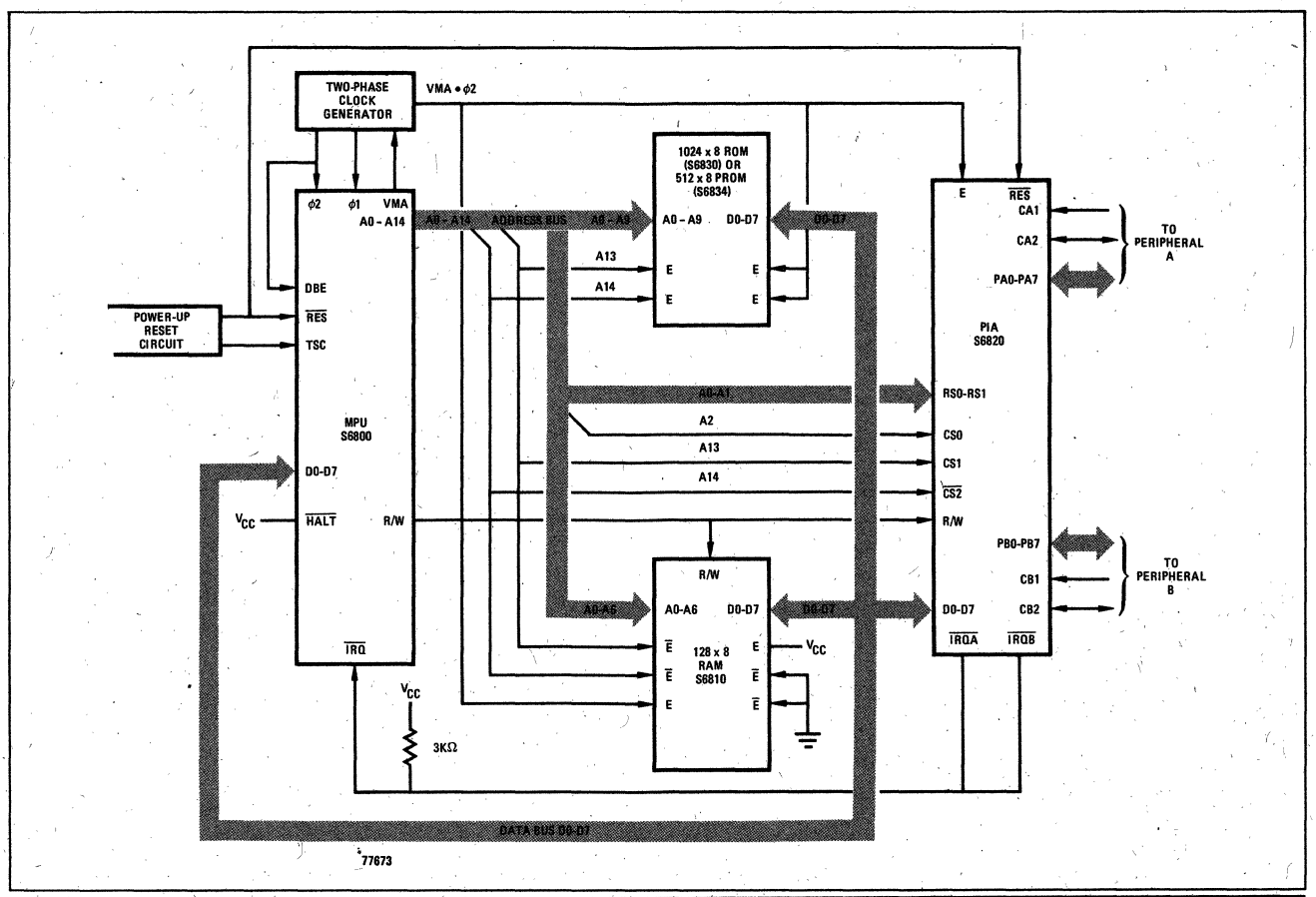
AN S6800 SYSTEM EXPANDS GRACEFULLY

The S6800 Microcomputer Family is easy to expand. It has every one of the basic types of memories – RAM, ROM, and PROM – and all essential forms of interfaces for digital telecommunication and peripherals – serial, parallel, asynchronous, and synchronous. System memory is easy to expand because multiple addressing modes of the MPU make memory access fast and efficient; all I/O devices are designed for operational flexibility and efficiency in MPU cycle utilization. Memory, I/O, and other devices in the S6800 family are all compatible in load levels and the entire system can run on one common clock. Consequently, you often can eliminate all circuit design, save for the simple clock and power-up/restart circuits.

In general, the system can be expanded in a modular manner by simply connecting the required devices onto the bus. These can be any combination of memory and input/output circuits. In this modular manner a system of nearly any complexity and configuration can be assembled. Because you are designing with a small number of integrated circuits, your circuit layout task is simple and the entire microcomputer can be located on a single circuit card. (Systems with more than ten devices on the bus require the addition of address and data bus buffers to operate at full speed).

In some special purpose applications you may need to attach your own interface devices to the bus. As a result, more circuit design will be required, but you will find the S6800 MPU easy to work with. It has features that allow it to be used in many different modes of operation and in various systems. For example, by using the Halt, Three State Control, and Data Bus Enable lines you can easily design a direct memory access system, in which either the MPU or a peripheral device can read or write into the RAM and utilize the bus on a priority basis. You can also design a multiprocessor system, in which several MPUs are attached to the same bus and share processing assignments, as well as memory space.

FIGURE 1 BASIC S6800 MICROCOMPUTER SYSTEM



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S6800 INPUT/OUTPUT

One other important advantage that S6800 has to offer in comparison with any other microcomputer system is input/output versatility. In any computer system, large or small, the CPU internal functions are determined by its architecture and the user usually has little opportunity or need to alter them. On the other hand, the I/O configuration is almost always determined by the user and subject to change as peripherals are added or other system alterations are introduced. The I/O configuration is important to the user because it affects the efficiency of the CPU itself, determines the ease and speed with which peripherals can interact with the system and determines the thruput rate of the system.

Therefore, the efficiency and versatility with which a CPU can handle its I/O – both in hardware and software – is an important criteria and of particular concern to the user. It is in this area that the S6800 MPU excels.

- In an S6800 system, the MPU relegates most of the I/O control to such I/O interfaces as the PIA or ACIA. Each of these circuits is programmable and can interface with peripheral devices without directly involving the MPU. For example, the MPU can preprogram a PIA to either input data into the MPU or to receive it. Thereafter, the PIA circuits assume all functions of interfacing with the peripherals and the MPU never has to look at the interface until service is required. It must service interrupts from the PIA, but never needs to wait for input data to become available or for output data to be accepted. This relieves the MPU of its I/O functions, makes it more efficient in its primary task of data processing, and significantly increases system thruput.

- The I/O interfaces and memory are both located in the same address space within the S6800 system. The MPU can access any I/O device the same as a memory location – with address lines, instead of separate I/O control lines. Therefore, it can manipulate data in the I/O interface registers with the same programmed instructions as it uses for memory locations. This adds programming flexibility and increases system efficiency.

- The S6800 Instruction Set complements the above I/O addressing capability with specific instructions that can be used to access memory as well as I/O circuit registers and perform directly various manipulations on the data.

S6800 INSTRUCTION SET

The S6800 MPU has a set of 72 basic instructions. These include binary and decimal arithmetic functions, as well as logical, shift, rotate, load, store, branch, interrupt, and stack manipulation functions. Most of the instructions have several variations and most can be used with several memory addressing modes. Thus, the total complex of instructions available to the programmer actually is 197.

An instruction can be from one to three bytes long, depending on the addressing mode used with the instruction. In single byte instructions no memory address is required because the operation is performed on one of the internal MPU registers. In multiple byte instructions the second and third byte can be the operand, or a memory address for the operand.

A noteworthy feature of the S6800 MPU is that some of the instructions can operate directly on any memory location. In most computer systems it is common that the processor fetches an operand from memory, stores it in the accumulator, then executes the operation in the ALU, and finally writes the result back into the memory. The S6800 is able to accomplish the same with only a single instruction, because it operates with any external location in the same manner as with an internal register. For example, it can directly increment or decrement the contents of a memory location. Because the MPU addresses I/O devices just like a memory location, it can do the same with registers inside the PIA or ACIA.

HARDWARE/SOFTWARE SUPPORT.

The S6800 Microcomputer Family hardware is completely supported by an array of application program development software, various levels of hardware and software reference documentation, a software development station, and a hardware prototyping evaluation board. These comprehensive software and hardware aids have many advanced timesaving features that make the S6800 software/hardware support structure the most modern and convenient.

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The program development software includes an Assembler, a Linking-Loader, and a Simulator program, all of which are suitable for direct implementation on large-scale computer systems and also are available through several timesharing networks. The reference documention consists of

- The S6800 Microprocessor Brochure
- The Software Data Brochure
- Assembly Language Programming Manual
- Hardware Reference Manual
- Other Application and User Information
- NCSS User's Guide

The Microprocessor Development Center is a complete self-contained S6800 microcomputer/keyboard/CRT, with a floppy disc. It provides the user with a complete, convenient, and economical hardware and software development facility. The MDC software includes an Assembler, Text Editor, and extensive Debug and Trace Package, and hardware Test Programs.

The EVK Series prototyping boards are fully functional microcomputers, with the MPU, ROM, RAM, and PROM memory, as well as I/O provisions on the board. The S6800 bus extends to the edge connector, so that any amount of external I/O can be connected also. It has a resident operating system program stored in ROM and all PROM programming hardware is right on the board. This board can be used for circuit evaluation, PROM programming, or as a microprocessor board in low quantity systems.

Cross-Assembler. The AMI 6800 Cross-Assembler is designed to operate on large-scale computers and converts S6800 Assembly Language input statements into machine language for the purpose of generating application programs. It defines the form and syntax according to which the S6800 instruction set can be structured into statements and thus forms the backbone for the usage of the S6800 Microcomputer System. The Cross-Assembler contains many advanced programming features for convenience and efficiency.

- Local Labels – a directive which permits symbol definition within a local region. Since the symbol is only referenced within that region, the same symbol can be reused in a different local region.
- Full Macro Capability – a sequence of instructions and associated variable parameters can be designated by a symbolic label. The assembler will substitute the complete sequence for the label, wherever the label is called out.
- Conditional Assembly – when parts of a program are the same for different versions of the program, the conditional assembly feature can be used to instruct the assembler to automatically include only those parts needed for a particular version of the program.

  Symbolic Expressions – symbolic labels can be used for memory locations as well as for program constants, thus generally simplifying the programmers task.

  Relocatable Program Segments – the object code within a program segment is always defined with respect to the start of the segment, thus allowing the Linking Loader to assign actual memory addresses later. This gives maximum flexibility in final assembly.
- Formatted Listings – assembly listings are formatted into 11-inch pages, with a two line header identifying the page number, date and time of assembly, program name, and column labels for the assembly printout.

The Cross-Assembler is available for computers supporting standard ANSI FORTRAN IV. For low-cost, high-speed program development, it is also written in SYSTEM 360/370 BAL and is available through timesharing networks, such as National CSS, Inc.

Linking Loader. – The Linking Loader is a program used to assign fixed memory locations to programs generated by the Cross-Assembler and thus structure the users program for a particular memory configuration. The Linking Loader is programmed to operate on the same (large-scale) computer as the Cross-Assembler and is also available on timesharing networks (NCSS and others). It can be used to produce a listing of the external definitions and load map, and a program tape suitable for a prototype system hexadecimal loader or a PROM programmer. Alternatively, it can also generate memory image file for use by the AMI S6800 Simulator program described below.

Simulator. – The AMI S6800 Simulator program is a means by which the user can conveniently check out the operation of programs written for the S6800. It is a program that can be operated on a cross-computer (other than S6800) and cause that computer to respond the same as a S6800 would.

The simulator simulates all S6800 Microprocessor hardware. A complete set of commands is provided for loading and examining the simulated registers and memory, and for controlling the simulator.

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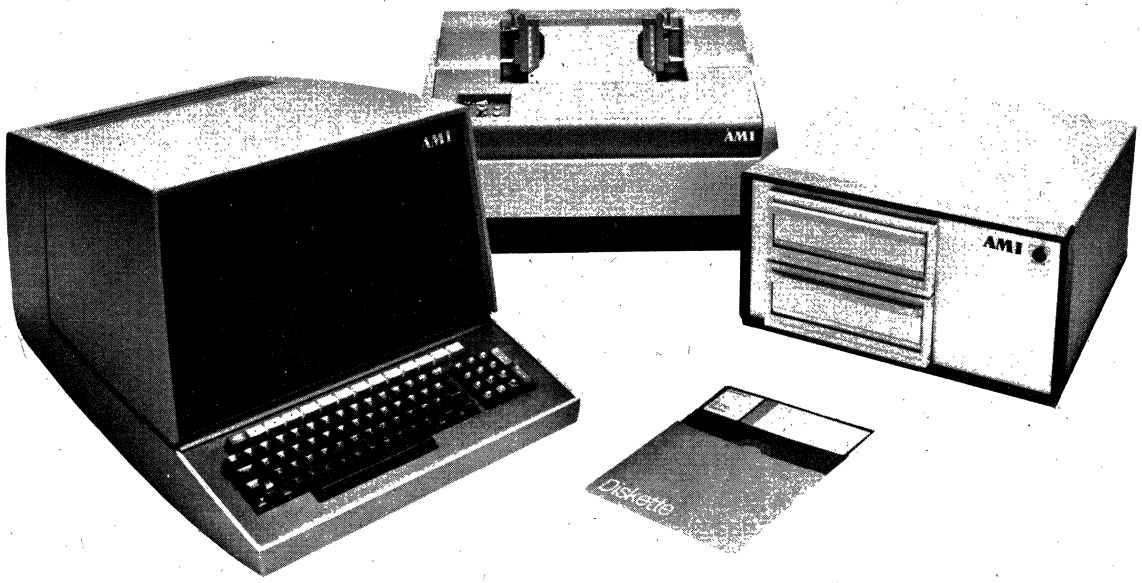
AMI 6800 Microcomputer Development Center

What is the AMI 6800 MDC? An intelligent standalone software development and hardware debugging station, serving completely the combined needs of the design engineer and the programmer. It consists of a S6800 based CRT/keyboard microcomputer terminal, a dual drive floppy disc memory, and an optional hard copy printer.

A program in development (or in operation) can be viewed on the CRT and edited on the keyboard. Program files can be assembled and stored in the floppy disk memory, under control of the disk memory operating system software. The modular bus oriented card cage in the CRT terminal provides versatile facilities for developing and testing 6800 hardware.



CRT/Keyboard Terminal

- Capability for generating 256 unique ASCII input characters
- 12-inch diagonal CRT display – 25 lines, 80 characters per line
- 16 K bytes of user available RAM, expandable to 48 K bytes
- Full cursor and editing controls
- Special function controls
- Peripheral interconnects

Standard MDC Card Modules

- S6800 MPU Card
- EPROM/ROM Program Storage Card
- RAM Card
- Keyboard/Telecommunications Card
- Debug Card
- Peripheral Interface Card
- EPROM Programmer Card
- CRT Driver and Refresh RAM Cards
- Optional Edit Board

Floppy Disk Memory

- IBM 3740 data format compatible
- Data storage capacity of 256,256 bytes per diskette
- Provides instant on-line access to over 500,000 bytes and virtually unlimited removable media storage
- Fully supported by FDOS-II Disk Operating and File Management System software
- Two full-sector buffers enable completely asynchronous data transfer at rates up to 500,000 bytes per second
- Diskettes available from AMI and multiple other sources

Optional Matrix Printer

Completely self contained impact printer, 120 cps, sprocket-fed, handles paper widths from 4 to 9½ inches. Can print original and four copies. Standard print format is 10 characters per inch horizontal, 6 lines per inch vertical. Buffered, 75,000 cps parallel transfer, optional serial interfaces allow from 100 to 9600 baud serial transfer.

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MDC Hardware Capabilities

The AMI 6800 MDC is a multifunction development center that single-handedly satisfies your requirements for software development, hardware development, and prototype checkout. The MDC can also double as a standalone communications terminal, a general purpose data processing system, or as an incoming parts tester.

Software Development – write, debug and operate S6800 programs on the CRT terminal, using its internal RAM and the dual drive floppy disc for storage. The MDC comes with a full complement of support software, including the FDOS-II Disk Operating and File Management System, a Text Editor, an Assembler, Debugger, Trace, Telecommunications and Utilities.

Hardware Development – breadboard such circuitry as interfaces or memories right on the MDC wirewrap prototyping board and plug into the CRT terminal card cage to operate with the MDC's S6800 based central processor in solving development problems. Use the control panel type functions of the CRT terminal for single step, stop-on-address, display, alter, and other similar program operations. The bus oriented card cage, position interchangeable plug-in card modules, and an extender card provide the flexibility to make hardware development easy. There is also a complete keyboard controlled PROM programmer within the CRT terminal.

Prototype Checkout – with the advantages of a real-time test environment, rapid test program retrieval, single or multiple step execution, and hardware as well as software breakpoints, the checkout of prototype S6800 circuitry is easy and efficient.

Standalone Communications Terminal – the CRT terminal has both RS-232 and current loop interfaces, supported by telecommunications firmware, for operation as a general purpose standalone intelligent terminal, as well as to supplement microcomputer development on a timeshare computer.

General Purpose Data Processing System – with FDOS-II Disk-based Operating and File Management System and up to 1 megabytes on-line file storage, the MDC can readily be used for data processing and other computer applications.

Incoming Parts Testing – because card and chip substitution is easy in the MDC, it is convenient for testing all 6800 parts.

MDC Software Capabilities

The AMI 6800 MDC offers total facilities for rapidly developing applications and systems software. The entire MDC software system is at the user's instant disposal – a few simple keystrokes are needed to instantly access and execute any program. The FDOS-II disk based operating system provides complete system resource control to the programmer.

FDOS-II Disk Operating and File Management System – contains a resident module for bootstrapping the floppy disk memory and for disk I/O handling. It also contains an exexutive that performs all of the disk memory command line interpretations, file management and operational functions of the dual disk system. In addition, there are utility I/O and EPROM programming routines in FDOS-II.

The Text Editor – program provides the means for rapidly creating, examining and modifying stored files. The total capability of MDC's Text Editor exceeds that of many large minicomputer systems, and includes such features as string searches and string substitutions.

The Symbolic Assembler – translates assembler language statements into executable machine language code. In conjunction with FDOS-II Operating and File Management System, assembling has been reduced to a series of simple operator keystrokes. Results of the assembly, automatically stored on disk, are immediately available for reference or execution.

MDC's Extensive Debug Program – effectively automates the functions of a computer control panel. Given control by simply pressing the DEBUG key or via program traps, Debug immediately responds with the display of machine and program status. Additional functions include:

- Register/data display and modification
- Instruction/subroutine step
- User definable debug macros
- Snapshot debug data of a running program
- Breakpoints (stop-on-address compare)
- Comment and header line displays

MDC's Trace Package – gives Debug the ability to display a trace of machine register contents, instruction mnemonics and operands before execution of any instruction or subroutine in the user's program. Microprocessor debugging has never been made easier.

MDC's Test Programs – are a set of self-test and diagnostics which verify that the hardware associated with the MDC is operating correctly. The programs are also helpful in isolating malfunctioning components. The program for testing the basic hardware is resident in EPROM and is activated by the keyboard TEST key.

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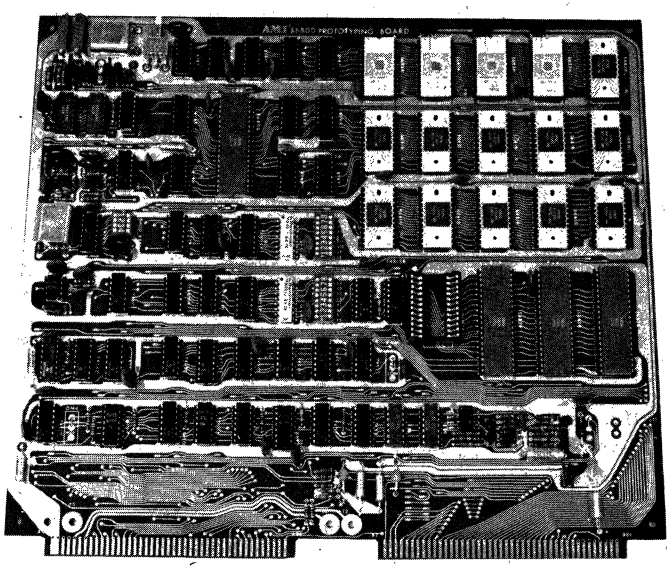
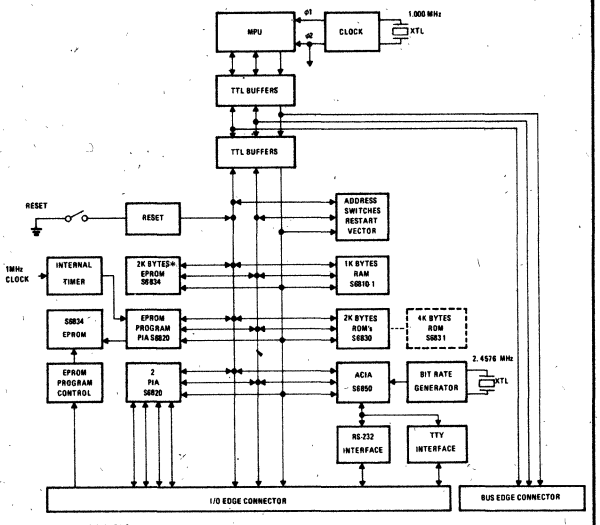
EVK200
EVK300

PROTOTYPING BOARDS

AMERICAN MICROSYSTEMS, INC.

ADVANCED PRODUCT DESCRIPTION





BLOCK DIAGRAM

FEATURES

- 2K Bytes ROM (4K using S6831)
- 2K Bytes EPROM (EVK300)
- 512 Bytes EPROM (EVK200)
- 1K Bytes RAM
- EPROM Programming for S6834
- 3 PIA's = 58 I/O Lines
- TTY Current Loop or RS232 Interface
- TTY Operating System Program
- ROM Subroutine Program Library
- Totally Buffered MPU Lines
- Single +5V Power Supply except when using EPROMs or RS232 Interface
- Restart Address Selection
- Selectable DMA Mode
- Interval Timer
- Tiny Basic

FUNCTIONAL DESCRIPTION

The EVK Series Prorotyping Board is a single PCB, hardware/software prototyping system. It allows system development using a functionally compatible system and reduced development time. With this board, the basic 6800 family parts (S6800, S6810-1, S6820, S6830, S6834 and S6850) can be evaluated. It can also serve as a general purpose microcomputer for low volume systems to which the user can easily add I/O and memory. The 10½" x 12" card has two edge connectors, one for the MPU Bus and one for I/O. The EVK 300 is a fully assembled board, but the EVK 200 is in a kit form.

All of the S6800 microprocessor lines are available at the bus edge connector and are buffered to allow 40 mA of drive capacity for expanding the development system. The standard system clock is adjustable from 300 kHz to 1MHz by using the potentiometers on the board. An optional 1 MHz crystal may be selected to control the accuracy for those applications requiring critical timings.

An on-board interval timer gives 1 ms and 100μs timing marks for general use and for EPROM programming. Three types of DMA operation are possible using the Prototyping Board, Halt Processor, Cycle Steal or Multiplexing.

MEMORY

Memory and I/O addresses are assigned to the upper 8K bytes of the available memory space. (See memory map for address assignments.) This gives the system developer the flexibility to use the remaining 56K bytes as he wishes. All of the memory and I/O on the board may be disabled externally by an edge connector line called MEMORY DISABLE, leaving the MPU free to operate totally in an external memory.

The S6830 ROMs contain the Prototype Operating Library (PROTO) and a ROM Subroutine Library $(RS)^3$. The 2K of EPROM locations may also be used for program

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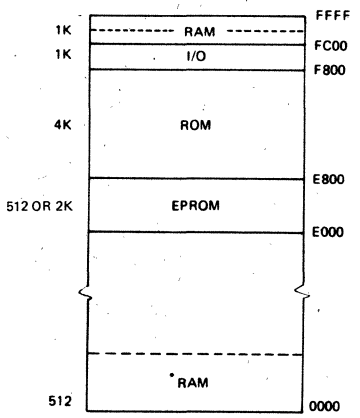
verification. The two S6830 ROM locations (1K x 8 each) will accept S6831 ROMs (2K x 8 each) and thus expand the ROM capacity to 4K bytes.

The RAM is assigned to the upper 1K of available memory space. The PROTO and $(RS)^3$ programs require about 256 bytes of this RAM so the rest is available for general programming. With all restart vectors automatically assigned to the upper memory addresses, restart vectoring is forced from a set of 16 switches. This allows the restart address to be vectored to any memory location.

The RAM has further been divided into two 512 byte sections such that the upper 512 bytes remain fixed in the assigned address block and the lower 512 bytes are moveable through a switch selection option. 512 bytes of RAM are relocatable to the lowest address space to take advantage of the S6800's direct addressing mode. This is only recommended if no external memory is added. When adding external memory, it is advisable to use the RAM in the upper address space and the external memory as the low addresses.

ADDRESS ASSIGNMENT MEMORY MAP



***Optional Low order RAM assignment**

I/O

An S6850 ACIA is used to provide a 20 mA current loop interface to a TTY or RS232 terminal. A 20 mA current loop interface and an EIA RS232 interface are both available on the board. A bit rate generator allows operation using any of the standard communication frequencies (see table) so a large variety of terminal types can be used.

Three S6820 PIAs allow up to 58 I/O lines, giving flexibility in I/O through the parallel interfaces.

TABLE

Communication Frequencies

50	baud	300	baud	19.2K baud
75	baud	600	baud	
110	baud	1200	baud	
134.5	baud	1800	baud	
150	baud	2400	baud	
200	baud	4800	baud	
		9600	baud	

EPROM PROGRAMMING

Unique to the AMI 6800 Prototyping Board is the ability to program S6834 EPROMs (512 x 8) on the board. The programming software can program an EPROM from any memory location, RAM, ROM or EPROM. It can verify a word and, if desired, change a single bit in the EPROM, provided that the change is from LOW to HIGH.

SOFTWARE

The Prototyping Board Software is comprised of a TTY Operating Program (PROTO) and is supported by a ROM Subroutine Library $(RS)^3$. The PROTO program operates on the following commands:

L	Load Memory from TTY paper tape
P	Punch a Memory location to TTY paper tape
S	Set Memory to a given value
D	Display the contents of a memory location
G	Go to a specific address and begin program execution
R	Print contents of MPU registers on the TTY
B	Burn (program) an EPROM from Memory location indicated
V	Verify the contents of an EPROM with a specified memory location
M	Move a specific block of memory to a designated location
E	End of transmission

The commands will operate on a single character op code plus address parameters from the TTY keyboard.

ROM SUBROUTINE LIBRARY

The ROM Subroutine Library $(RS)^3$ operates on a single SWI (3F) command and a second byte of offset giving the S6800 an additional set of two-byte instructions. Specific subroutines (offsets) are as follows.

SUBROUTINE	MNEMONIC	FUNCTION
0	PUSHALL	All registers are pushed on to user stack
1	POPALL	All registers on user stack are loaded into MPU
2	TXAB	Contents of Index Register are transferred to A & B Accumulators

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SOFTWARE (Cont.)

3	TABX	Contents of A & B Accumulators are transferred to Index Register
4	XABX	Contents of A & B Accumulators are exchanged with contents of Index Register
5	PUSX	Contents of Index Register are pushed onto user stack
6	PULX	Index Register is loaded with contents of user stack
7	ADDXAB	Contents of Index Register are added to contents of A & B Accumulators. Sum is in A & B Accumulators.
8	ADDABX	Contents of A & B Accumulators are added to contents of Index Register. Sum is in Index Register
9	ADDAX	Contents of Accumulator A are added to contents of Index Register. Sum is in Index Register
10	ADDBX	Contents of Accumulator A are added to contents of Index Register. Sum is in Index Register
11	SUBXAB	Contents of Index Register are subtracted from contents of A & B Accumulators. Remainder is in Accumulators A & B
12	SUBABX	Contents of Accumulators are subtracted from contents of Index Register. Remainder is in Index Register
13	SUBAX	Contents of Accumulator A are subtracted from contents of Index Register. Remainder is in Index Register.
14	SUBBX	Contents of Accumulator B are subtracted from contents of Index Register. Remainder is in Index Register
15	P2HEX	Two Hexidecimal Characters (one MPU byte) are printed on the TTY
16	P4HEX	Four Hexidecimal Characters (two MPU bytes) are printed on the TTY
17	PRINTA	ASCII Character designated is printed on TTY
18	PMESS	Message designated is printed on TTY
19	VALAN	Character (byte) is checked to see if it is a valid alpha/numeric character
20	INPUTA	ASCII Character at TTY is input to MPU
21	CONHB	ASCII Character string is scanned looking for a valid Hexidecimal number. Binary equivalent is returned in Accumulators A & B
22	INDEX	Contents of Accumulator A are multiplied with the contents of Accumulator B and the product is added to the contents of the Index Register
23	MUL8	Contents of Accumulator A are multiplied with the contents of Accumulator B. Product remains in both Accumulators

AN EXCLUSIVE BONUS – AMI 6800 TINY BASIC
–a high level interpretive language derived from the standard Dartmouth Basic. Furnished to EVK 300 users at no charge upon submittal of warranty registration.

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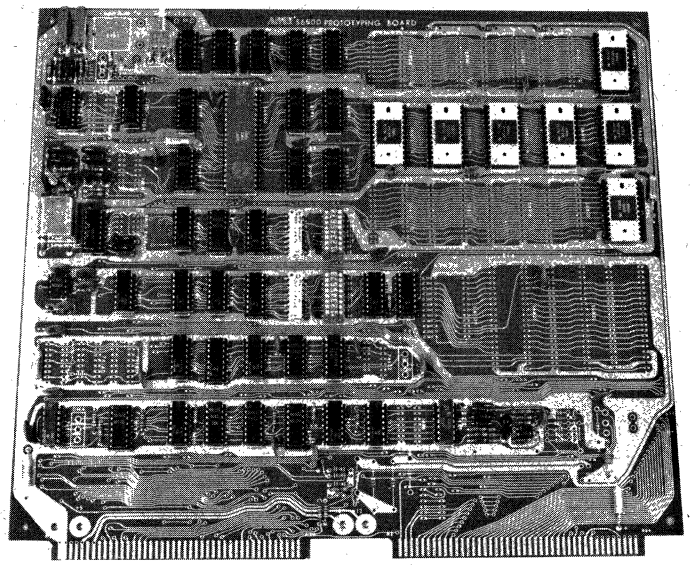
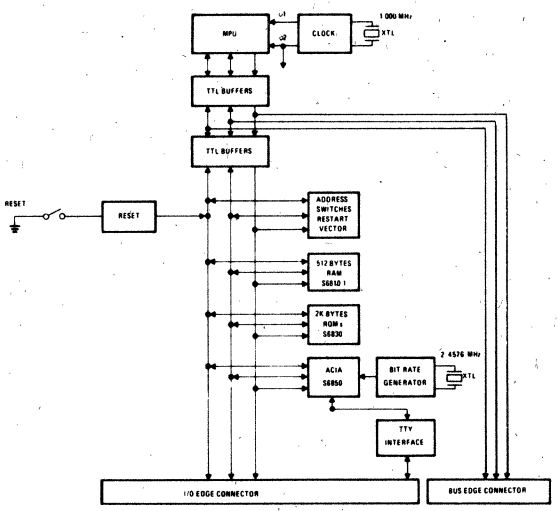
AMERICAN MICROSYSTEMS, INC.

EVK99
EVK100
PROTOTYPING KIT

ADVANCED PRODUCT DESCRIPTION





BLOCK DIAGRAM

FEATURES

- 2K Bytes ROM
- 512 Bytes RAM
- TTY Current Loop Interface
- TTY Operating System Program
- ROM Subroutine Program Library
- Totally Buffered MPU Lines
- Single +5V Power Supply
- Restart Address Selection
- Expandable to EVK 300

FUNCTIONAL DESCRIPTION

The EVK 100 Prototyping Board is a kit for a single PCB, hardware/software prototyping system. It allows system development using a functionally compatible system and reduced development time. With this board, the basic 6800 family parts (S6800, S6810-1, S6820, S6830, S6834 and S6850) can be evaluated. It can also serve as a general purpose microcomputer for low volume systems to which the user can easily add I/O and memory. The 10½" x 12" card has two edge connectors, one for the MPU Bus and one for I/O.

All of the S6800 microprocessor lines are available at the bus edge connector and are buffered to allow 40 mA of drive capacity for expanding the development system. The standard system clock is adjustable from 300 kHz to 1MHz by using the potentiometers on the board.

The EVK 99 is a minimum kit that includes the printed circuit board, the S6800 MPU, four S6810 RAMs (128 bytes each), two S6830 ROMs (1K bytes each), the S6820 Peripheral Interface Adapter, and the S6850 Asynchronous Communications Interface Adapter. The circuit board is identical to all other EVK Series boards and therefore allows expansion to any more complex EVK configuration. Software in the ROMs is identical to that in EVK 100.

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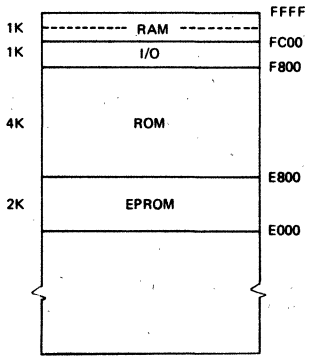
MEMORY

Memory and I/O addresses are assigned to the upper 8K bytes of the available memory space. (See memory map for address assignments.) This gives the system developer the flexibility to use the remaining 56K bytes as he wishes. All of the memory and I/O on the board may be disabled externally by an edge connector line called MEMORY DISABLE, leaving the MPU free to operate totally in an external memory.

The S6830 ROMs contain the Prototype Operating Library (PROTO) and a ROM Subroutine Library $(RS)^3$. The two S6830 ROM locations (1K x 8 each) will accept S6831 ROMs (2K x 8 each) and thus expand the ROM capacity to 4K bytes.

The RAM is assigned to the upper 512 bytes of available memory space. The PROTO and $(RS)^3$ programs require about 256 bytes of this RAM so the rest is available for general programming. With all restart vectors automatically assigned to the upper memory addresses, restart vectoring is forced from a set of 16 switches. This allows the restart address to be vectored to any memory location (EVK 100 only).

ADDRESS ASSIGNMENT MEMORY MAP



I/O

An S6850 ACIA is used to provide a 20 mA current loop interface to a TTY. A bit rate generator allows operation using any of the standard communication frequencies (see table) so a large variety of terminal types can be used.

TABLE

Communication Frequencies

50	baud	300	baud	19.2K baud
75	baud	600	baud	
110	baud	1200	baud	
134.5	baud	1800	baud	
150	baud	2400	baud	
200	baud	4800	baud	
		9600	baud	

SOFTWARE

The Prototyping Board Software is comprised of a TTY Operating Program (PROTO) and is supported by a ROM Subroutine Library $(RS)^3$. The PROTO program operates on the following commands:

L	Load Memory from TTY paper tape
P	Punch a Memory location to TTY paper tape
S	Set Memory to a given value
D	Display the contents of a memory location
G	Go to a specific address and begin program execution
R	Print contents of MPU registers on the TTY
M	Move a specific block of memory to a designated location
E	End of transmission

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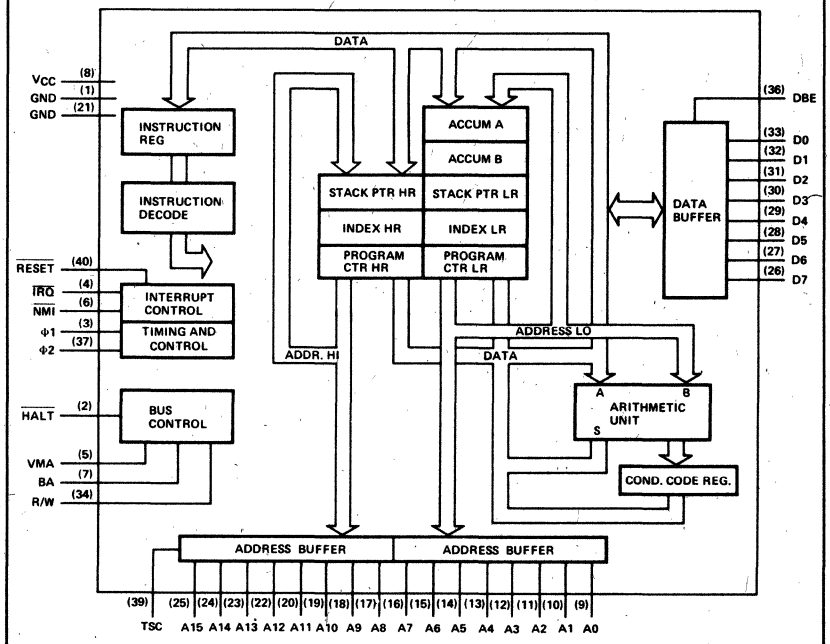
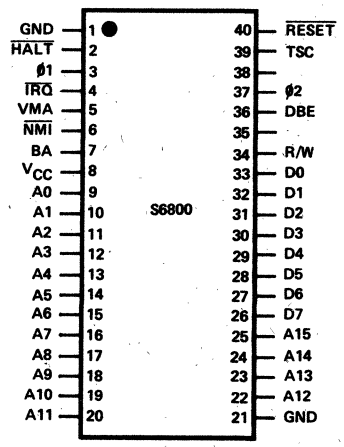
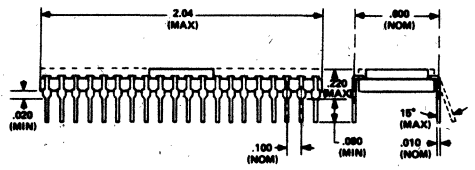
S6800

8-BIT
MICROPROCESSOR



BLOCK DIAGRAM





PIN/PACKAGE CONFIGURATION

FEATURES

- Eight-Bit Parallel Processing
- Bi-Directional Data Bus
- Sixteen-Bit Address Bus – 65536 Bytes of Addressing
- 72 Instructions – Variable Length
- Seven Addressing Modes – Direct, Relative, Immediate, Indexed, Extended, Implied and Accumulator
- Variable Length Stack
- Vectored Restart
- 2 Microsecond Instruction Execution
- Maskable Interrupt Vector
- Separate Non-Maskable Interrupt – Internal Registers Saved in Stack
- Six Internal Registers – Two Accumulators, Index Register, Program Counter, Stack Pointer and Condition Code Register
- Direct Memory Access (DMA) and Multiple Processor Capability
- Clock Rates as High as 1 MHz
- Simple Bus Interface Without TTL
- Halt and Single Instruction Execution Capability

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ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC}	-0.3 to +7.0V
Input Voltage V_{in}	-0.3 to +7.0V
Operating Temperature Range T_A	0 to +70°C
Storage Temperature Range T_{stg}	-55 to +150°C

DC (STATIC) CHARACTERISTICS

(V_{CC} = 5.0 V ± 5%, T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Input High Voltage (Normal Operating Levels)					Vdc
Logic	V_{IH}	+ 2.4	–	V_{CC}	
$\phi1,\phi2$	V_{IHC}	V_{CC} –0.3	–	V_{CC} +0.1	
Input Low Voltage (Normal Operating Levels)					Vdc
Logic	V_{IL}	–0.3	–	+ 0.4	
$\phi1,\phi2$	V_{ILC}	–0.1	–	+0.3	
Clock Overshoot/Undershoot – Input High Level	V_{OS}	V_{CC} –0.5	–	V_{CC} +0.5	Vdc
– Input Low Level		–0.5	–	+0.5	
Input High Threshold Voltage	V_{IHT}				Vdc
$\overline{Reset}$, $\overline{NMI}$, $\overline{Halt}$, $\overline{IRQ}$, Data		+ 2.0	–	–	
Input Low Threshold Voltage	V_{ILT}				Vdc
$\overline{Reset}$, $\overline{NMI}$, $\overline{Halt}$, $\overline{IRQ}$, Data		–	–	+ 0.8	
Input Leakage Current	I_{in}				μAdc
(V_{in} = 0 to 5.25 V, V_{CC} = 5.25V) Logic*		–	–	2.5	
$\phi1,\phi2$		–	–	100	
Three-State (Off State) Input Current	I_{TSI}				μAdc
(V_{in} = 0.4 to 2.4 V, V_{CC} = max) Data		–	–	10	
A0-A15, R/W		–	–	100	
Output High Voltage	V_{OH}				Vdc
(I_{Load} = –100 μAdc, V_{CC} = min)		+ 2.4	–	–	
Output Low Voltage	V_{OL}				Vdc
(I_{Load} = 1.6 mAdc, V_{CC} = min)		–	–	+ 0.4	
Power Dissipation	P_D	–	0.600	1.2	W
Capacitance**	C_{in}				pF
(V_{in} = 0, T_A = 25°C, f = 1.0 MHz) Logic		–	–	10	
Data, TSC		–	–	15	
$\phi1,\phi2$		80	120	160	
A0-A15, R/W	C_{out}	–	–	12	pF

*Except IRQ and NMI, which require 3 kΩ pullup load resistors for wire-OR capability at optimum operation.
**Capacitances are periodically sampled rather than 100% tested.

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AC (DYNAMIC) CHARACTERISTICS

(V_{CC} = 5.0 volt ± 5%, T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min.	Typ	Max.	Unit
Frequency of Operation	f	0.1	–	1.0	MHz
Clock Timing for 1-MHz Operation (Figure 1) (C_{clock} = 200 pF) Cycle Time	t_{cyc}	1.0	–	10	μs
Clock Pulse Width (Measured at V_{CC} –0.3 V) $\phi1$	$PW_{\phi H}$	430	–	4500	ns
$\phi2$		450	–	4500	
Total $\phi1$ and $\phi2$ UP Time	t_{ut}	940	–	–	ns
Rise and Fall Times $\phi1,\phi2$ (Measured between 0.3 V and V_{CC} –0.3 V)	t_r, t_f	5.0	–	50	ns
Delay Time or Clock Overlap (Measured at 0.5 V)	t_d	0	–	9100	ns
Overshoot/Undershoot Duration	t_{os}	0	–	40	ns

READ/WRITE TIMING

Figures 2 and 3, f = 1.0 MHz, Loading = 130 pF and one TTL Load except VMA and BA Loading = 30 pF and one

Characteristic	Symbol	Min.	Typ	Max.	Unit
Read/Write Setup Time from MPU	T_{ASR}	–	100	300	ns
Address Setup Time from MPU	T_{ASC}	–	200	300	ns
Memory Read Access Time $t_{cyc} - (T_{ASC} + T_{DSU} + t_r)$	T_{ACC}	–	–	575	ns
Data Setup Time	T_{DSU}	100	–	–	ns
Address Setup Time from MPU for VMA	T_{VSC}	–	150	300	ns
Data Hold Time	T_H	10	30	–	ns
Enable High Time for DBE Input	T_{EH}	470	–	–	ns
Data Setup Time from MPU	T_{ASD}	–	150	200	ns

FIGURE 1 – CLOCK TIMING WAVEFORM

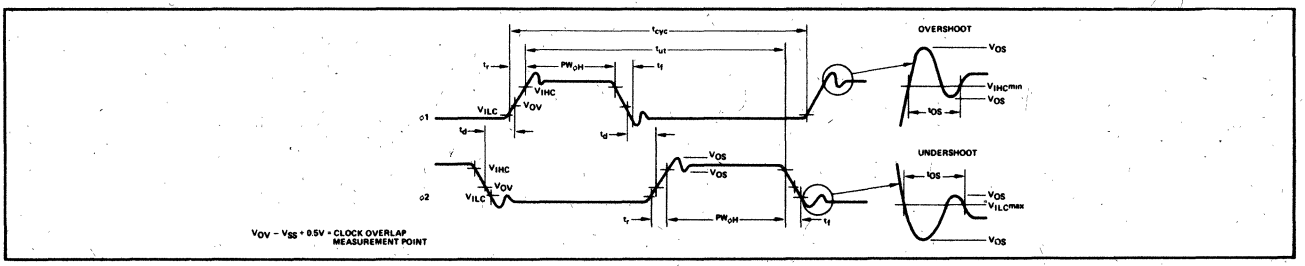

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FIGURE 2 – READ DATA FROM MEMORY OR PERIPHERALS

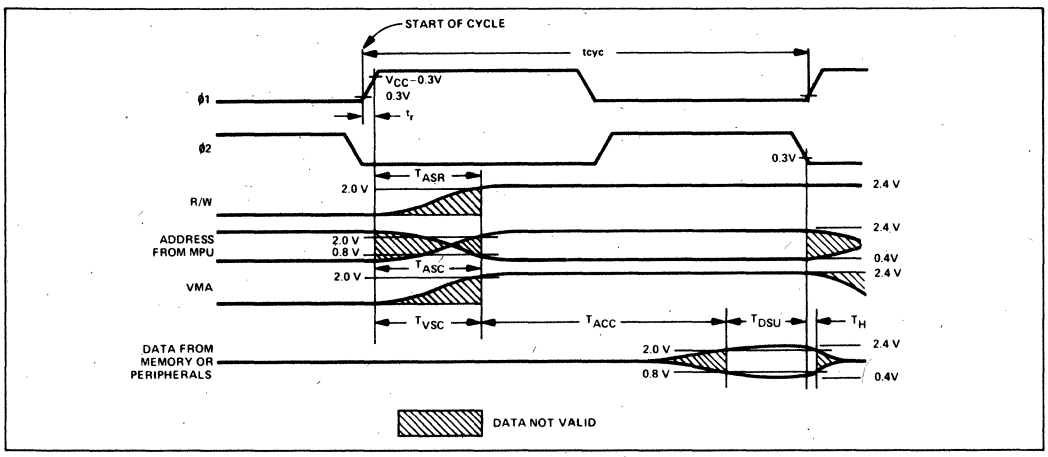
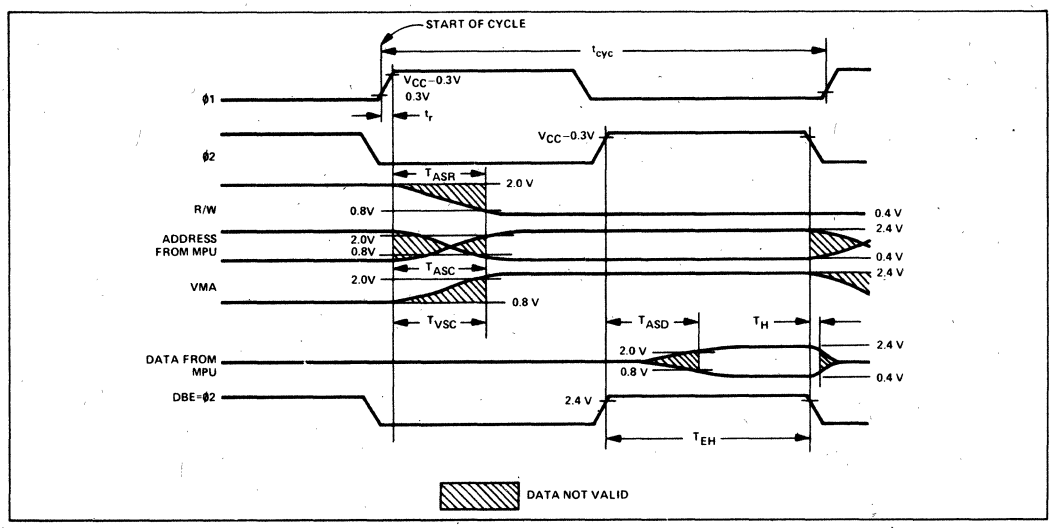


FIGURE 3 – WRITE DATA IN MEMORY OR PERIPHERALS



INTERFACE DESCRIPTION

Pin	Label	Function
ϕ1	(3)	**Clocks Phase One and Phase Two** – Two pins are used for a two-phase non-overlapping clock that runs at the V_{CC} voltage level.
ϕ2	(37)	
$\overline{\text{RESET}}$	(40)	**$\overline{\text{Reset}}$** – This input is used to reset and start the MPU from a power down condition, resulting from a power failure or an initial start-up of the processor. If a positive edge is detected on the input, this will signal the MPU to begin the restart sequence. This will start execution of a routine to initialize the processor from its reset condition. All the higher order address lines will be forced high. For the restart, the last two (FFFE, FFFF) locations in memory will be used to load the program that is addressed by the program counter. During the restart routine, the interrupt mask bit is set and must be reset before the MPU can be interrupted by $\overline{\text{IRQ}}$. $\overline{\text{Reset}}$ must be held low for at least eight clock periods after V_{CC} reaches 4.75 volts (Figure 4). If $\overline{\text{Reset}}$ goes high prior to the leading edge of ϕ2, on the next ϕ1 the first restart memory vector address (FFFE) will appear on the address lines. This location should contain the higher order eight bits to be stored into the program counter. Following, the next address FFFF should contain the lower order eight bits to be stored into the program counter.

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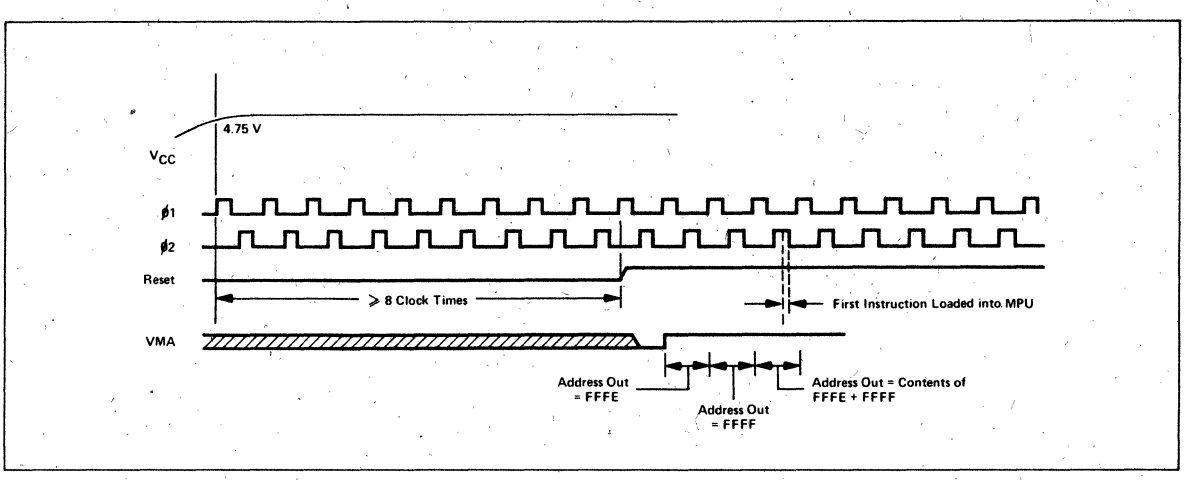
FIGURE 4 INITIALIZATION OF MPU AFTER RESTART



INTERFACE DESCRIPTION (CONT'D)

Pin	Label	Function
VMA	(5)	**Valid Memory Address** – This output indicates to peripheral devices that there is a valid address on the address bus. In normal operation, this signal should be utilized for enabling peripheral interfaces such as the PIA and ACIA. This signal is not three-state. One standard TTL load and 30 pF may be directly driven by this active high signal.
A0 • • • A15	(9) (25)	**Address Bus** – Sixteen pins are used for the address bus. The outputs are three-state bus drivers capable of driving one standard TTL load and 130 pF. When the output is turned off, it is essentially an open circuit. This permits the MPU to be used in DMA applications.
TSC	(39)	**Three-State Control** – This input causes all of the address lines and the Read/Write line to go into the off or high impedance state. This state will occur 500 ns after TSC = 2.4 V. The Valid Memory Address and Bus Available signals will be forced low. The data bus is not affected by TSC and has its own enable (Data Bus Enable). In DMA applications, the Three-State Control line should be brought high on the leading edge of the Phase One Clock. The $\phi 1$ clock must be held in the high state and the $\phi 2$ in the low state for this function to operate properly. The address bus will then be available for other devices to directly address memory. Since the MPU is a dynamic device, it can be held in this state for only 5.0 μs or destruction of data will occur in the MPU.
D0 • • D7	(33) (26)	**Data Bus** – Eight pins are used for the data bus. It is bi-directional, transferring data to and from the memory and peripheral devices. It also has three-state output buffers capable of driving one standard TTL load at 130 pF.
DBE	(36)	**Data Bus Enable** – This input is the three-state control signal for the MPU data bus and will enable the bus drivers when in the high state. This input is TTL compatible; however in normal operation, it can be driven by the phase two clock. During an MPU read cycle, the data bus drivers will be disabled internally. When it is desired that another device control the data bus such as in Direct Memory Access (DMA) applications, DBE should be held low.
R/W	(34)	**Read/Write** – This TTL compatible output signals the peripherals and memory devices whether the MPU is in a Read (high) or Write (low) state. The normal standby state of this signal is Read (high). Three-State Control going high will turn Read/Write to the off (high-impedance) state. Also, when the processor is halted, it will be in the off state. This output is capable of driving one standard TTL load and 130 pF.

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INTERFACE DESCRIPTION (CONT'D)

Pin	Label	Function
$\overline{HALT}$	(2)	**$\overline{Halt}$** – When this input is in the low state, all activity in the machine will be halted. This input is level sensitive. In the halt mode, the machine will stop at the end of an instruction, Bus Available will be at a one level, Valid Memory Address will be at a zero, and all other three-state lines will be in the three-state mode. Transition of the $\overline{Halt}$ line must not occur during the last 250 ns of phase one. To insure single instruction operation, the $\overline{Halt}$ line must go high for one Phase One Clock cycle.
BA	(7)	**Bus Available** – The Bus Available signal will normally be in the low state; when activated, it will go to the high state indicating that the microprocessor has stopped and that the address bus is available. This will occur if the $\overline{Halt}$ line is in the low state or the processor is in the WAIT state as a result of the execution of a WAIT instruction. At such time, all three-state output drivers will go to their off state and other outputs to their normally inactive level. The processor is removed from the WAIT state by the occurrence of a maskable (mask bit I = 0)or nonmaskable interrupt. This output is capable of driving one standard TTL load and 30 pF.
$\overline{IRQ}$	(4)	**$\overline{Interrupt\ Request}$** – This level sensitive input requests that an interrupt sequence be generated within the machine. The processor will wait until it completes the current instruction that is being executed before it recognizes the request. At that time, if the interrupt mask bit in the Condition Code Register is not set, the machine will begin an interrupt sequence. The Index Register, Program Counter, Accumulators, and Condition Code Register are stored away on the stack. Next the MPU will respond to the interrupt request by setting the interrupt mask bit high so that no further interrupts may occur. At the end of the cycle, a 16-bit address will be loaded that points to a vectoring address which is located in memory locations FFF8 and FFF9. An address loaded at these locations causes the MPU to branch to an interrupt routine in memory. The $\overline{Halt}$ line must be in the high state for interrupts to be recognized. The $\overline{IRQ}$ has a high impedance pullup device internal to the chip; however a 3 kΩ external resistor to V_{CC} should be used for wire-OR and optimum control of interrupts.
$\overline{NMI}$	(6)	**$\overline{Non\text{-}Maskable\ Interrupt}$** – A low-going edge on this input requests that a non-mask interrupt sequence be generated within the processor. As with the $\overline{Interrupt\ Request}$ signal, the processor will complete the current instruction that is being executed before it recognizes the $\overline{NMI}$ signal. The interrupt mask bit in the Condition Code Register has no effect on $\overline{NMI}$. The Index Register, Program Counter, Accumulators, and Condition Code Register are stored away in the stack. At the end of the cycle, a 16-bit address will be loaded that points to a vectoring address which is located in memory locations FFFC and FFFD. An address loaded at these locations causes the MPU to branch to a non-maskable interrupt routine in memory. $\overline{NMI}$ has a high impedance pullup resistor internal to the chip; however a 3 kΩ external resistor to V_{CC} should be used for wire-OR and optimum control of interrupts. Inputs $\overline{IRQ}$ and $\overline{NMI}$ are hardware interrupt lines that are acknowledged during $\phi 2$ and will start the interrupt routine on the $\phi 1$ following the completion of an instruction. INTERRUPTS – As outlined in the interface description the S6800 requires a 16-bit vector address to indicate the location of routines for Restart, Non-maskable Interrupt, and Maskable Interrupt. Additionally an address is required for the Software Interrupt Instruction (SWI). The processor assumes the uppermost eight memory locations, FFF8 – FFFF, are assigned as interrupt vector addresses as defined in Figure 5. After completing the current instruction execution the processor checks for an allowable interrupt request via the $\overline{IRQ}$ or $\overline{NMI}$ inputs as shown by the simplified flow chart in Figure 6. Recognition of either external interrupt request or a Wait for Interrupt (WAI) or Software Interrupt (SWI) instruction causes the contents of the Index Register, Program Counter, Accumulators and Condition Code Register to be transferred to the stack as shown in Figure 7.

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FIGURE 5 MEMORY MAP FOR INTERRUPT VECTORS

Vector MS	Vector LS	Description
FFFE	FFFF	Restart
FFFC	FFFD	Non-maskable Interrupt
FFFA	FFFB	Software Interrupt
FFF8	FFF9	Interrupt Request

FIGURE 6 – MPU FLOW CHART

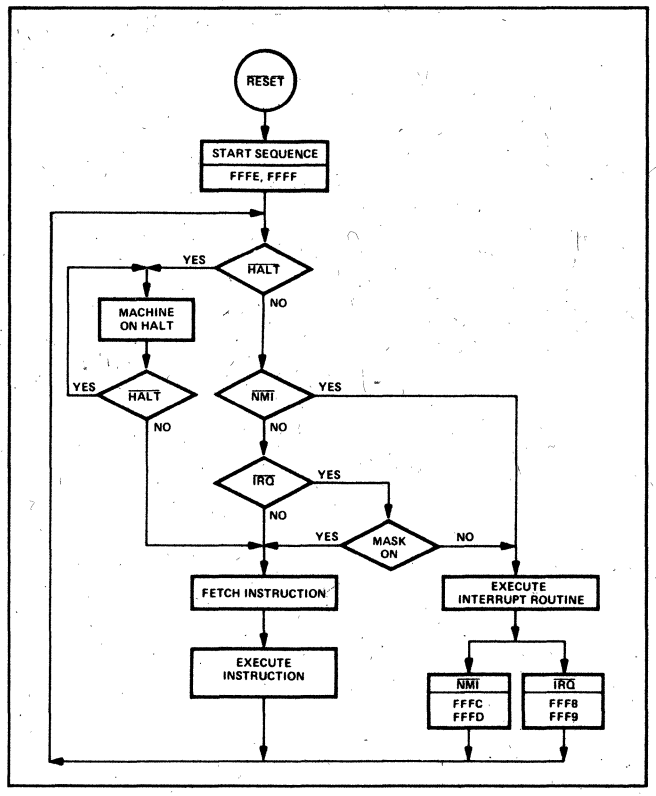
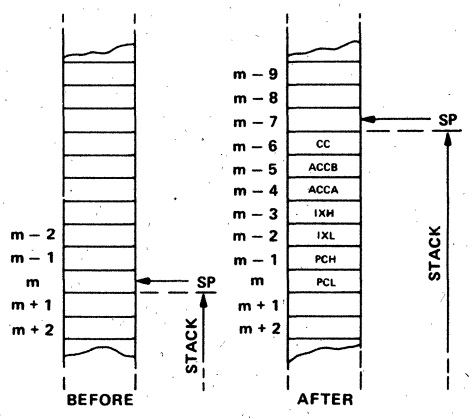
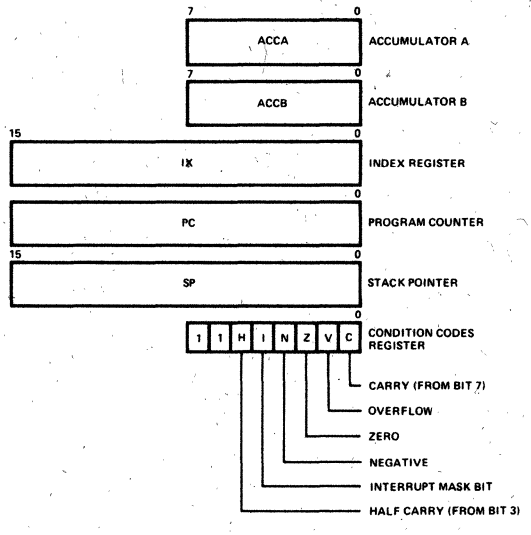


FIGURE 7 – SAVING THE STATUS OF THE MICROPROCESSOR IN THE STACK



SP = Stack Pointer
CC = Condition Codes
Also called the Processor Status Byte)
ACCB = Accumulator B
ACCA = Accumulator A
IXH = Index Register, Higher Order 8 Bits
IXL = Index Register, Lower Order 8 Bits
PCH = Program Counter, Higher Order 8 Bits
PCL = Program Counter, Lower Order 8 Bits

FIGURE 8 – PROGRAMMING MODEL OF THE MICROPROCESSOR



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MPU REGISTERS

The MPU has three 16-bit registers and three 8-bit registers available for use by the programmer.

Program Counter – The program counter is a two byte (16-bits) register that points to the current program address.

Stack Pointer – The stack pointer is a two byte register that contains the address of the next available location in an external push-down/pop-up stack. This stack is normally a random access Read/Write memory that may have any location (address) that is convenient. In those applications that require storage of information in the stack when power is lost, the stack must be non-volatile.

Index Register – The index register is a two byte register that is used to store data or a sixteen bit memory address for the Indexed mode of memory addressing.

Accumulators – The MPU contains two 8-bit accumulators that are used to hold operands and results from the arithmetic logic unit (ALU).

Condition Code Register – The condition code register indicates the results of an Arithmetic Logic Unit operation: Negative (N), Zero (Z), Overflow (V), Carry from bit 7 (C), and half carry from bit 3 (H). These bits of the Condition Code Register are used as testable conditions for the conditional branch instructions. Bit 4 is the interrupt mask bit (I). The unused bits of the Condition Code Register (b6 and b7) are ones.

MPU ADDRESSING MODES

The S6800 eight-bit microprocessing unit has seven address modes that can be used by a programmer, with the addressing mode a function of both the type of instruction and the coding within the instruction. A summary of the addressing modes for a particular instruction can be found in Figure 9 along with the associated instruction execution time that is given in machine cycles. With a clock frequency of 1 MHz, these times would be microseconds.

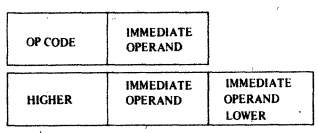
ACCUMULATOR ADDRESSING (ACCX)

A single byte instruction addressing operands only in accumulator A or accumulator B.

IMPLIED ADDRESSING

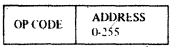
Single byte instruction where the operand address is implied by the instruction definition (i.e., Stack Pointer, Index Register or Condition Register).

IMMEDIATE ADDRESSING



Two or three byte instructions with an eight or sixteen bit operand respectively. For accumulator operations the eight bit operand is contained in the second byte of a two byte instruction. For Index Register operations (e.g. LDX) sixteen bit operand is contained in the second and third byte of a three byte instruction.

DIRECT ADDRESSING

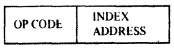


Two byte instructions with the address of the operand contained in the second byte of the instruction. This format allows direct addressing of operands within the first 256 memory locations.

EXTENDED ADDRESSING

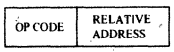
Three byte instructions with the higher eight bits of the operand address contained in the second byte and the lower eight bits of address contained in the third byte of the instruction. This format allows direct addressing of all 65,536 memory locations.

INDEXED ADDRESSING



Two byte instructions where the 8 bit unsigned address contained in the second byte of the instruction is added to the sixteen bit Index Register resulting in a sixteen bit effective address. The effective address is stored in a temporary register and the contents of the Index Register are unchanged.

RELATIVE ADDRESSING



Two byte instructions where the relative address contained in the second byte of the instruction is added to the sixteen bit program counter plus two. The relative address is interpreted as a two's complement number allowing relative addressing within a range of −125 to +129 bytes of the present instruction.

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FIGURE 9 – S6800 INSTRUCTION SET

		Addressing Mode							Condition Reg
		Implied	Immediate	Direct	Extended	Indexed	Relative	Boolean/Arith	5 4 3 2 1 0
Instruction	Mnemonic	OP MC PB	OP MC PB	OP MC PB	OP MC PB	OP MC PB	OP MC PB	Operation	H I N Z V C
Load accumulator	LDAA		86 2 2	96 3 2	B6 4 3	A6 5 2		M → A	• • ↕ ↕ R •
	LDAB		C6 2 2	D6 3 2	F6 4 3	E6 5 2		M → B	• • ↕ ↕ R •
Load stack pointer	LDS		8E 3 3	9E 4 2	BE 5 3	AE 6 2		M → SP_H, (M + 1) → SP_L	• • 9 ↕ R •
Load index register	LDX		CE 3 3	DE 4 2	FE 5 3	EE 6 2		M → X_H, (M + 1) → X_L	• • 9 ↕ R •
Store accumulator	STAA			97 4 2	B7 5 3	A7 6 2		A → M	• • ↕ ↕ R •
	STAB			D7 4 2	F7 5 3	E7 6 2		B → M	• • ↕ ↕ R •
Store stack pointer	STS			9F 5 2	BF 6 3	AF 7 2		SP_H → M, SP_L → (M + 1)	• • 9 ↕ R •
Store index register	STX			DF 5 2	FF 6 3	EF 7 2		X_H → M, X_L → (M + 1)	• • 9 ↕ R •
Transfer accumulators	TAB	16 2 1						A → B	• • ↕ ↕ R •
	TBA	17 2 1						B → A	• • ↕ ↕ R •
Transfer Acc. to cond. reg.	TAP	06 2 1						A → CCR	Note 12
Transfer cond. reg. to Acc.	TPA	07 2 1						CCR → A	• • • • • •
Transfer stck ptr to index	TSX	30 4 1						SP + 1 → X	• • • • • •
Transfer index to stck ptr	TXS	35 4 1						X − 1 → SP	• • • • • •
Pull data	PULA	32 4 1						SP + 1 → SP, M_{SP} → A	• • • • • •
	PULB	33 4 1						SP + 1 → SP, M_{SP} → B	• • • • • •
Push data	PSHA	36 4 1						A → M_{SP}, SP − 1 → SP	• • • • • •
	PSHB	37 4 1						B → M_{SP}, SP − 1 → SP	• • • • • •
Add accumulators	ABA	1B 2 1						A + B → A	↕ • ↕ ↕ ↕ ↕
Add	ADDA		8B 2 2	9B 3 2	BB 4 3	AB 5 2		A + M → A	↕ • ↕ ↕ ↕ ↕
	ADDB		CB 2 2	DB 3 2	FB 4 3	EB 5 2		B + M → B	↕ • ↕ ↕ ↕ ↕
Add with carry	ADCA		89 2 2	99 3 2	B9 4 3	A9 5 2		A + M + C → A	↕ • ↕ ↕ ↕ ↕
	ADCB		C9 2 2	D9 3 2	F9 4 3	E9 5 2		B + M + C → B	↕ • ↕ ↕ ↕ ↕
Subtract accumulators	SBA	10 2 1						A − B → A	• • ↕ ↕ ↕ ↕
Subtract	SUBA		80 2 2	90 3 2	B0 4 3	A0 5 2		A − M → A	• • ↕ ↕ ↕ ↕
	SUBB		C0 2 2	D0 3 2	F0 4 3	E0 5 2		B − M → B	• • ↕ ↕ ↕ ↕
Subtract with carry	SBCA		82 2 2	92 3 2	B2 4 3	A2 5 2		A − M − C → A	• • ↕ ↕ ↕ ↕
	SBCB		C2 2 2	D2 3 2	F2 4 3	E2 5 2		B − M − C → B	• • ↕ ↕ ↕ ↕
Increment	INCA	4C 2 1						A + 1 → A	• • ↕ ↕ 5 •
	INCB	5C 2 1						B + 1 → B	• • ↕ ↕ 5 •
	INC				7C 6 3	6C 7 2		M + 1 → M	• • ↕ ↕ 5 •
Increment stack pointer	INS	31 4 1						SP + 1 → SP	• • • • • •
Increment index reg.	INX	08 4 1						X + 1 → X	• • • ↕ • •
Decrement	DECA	4A 2 1						A − 1 → A	• • ↕ ↕ 4 •
	DECB	5A 2 1						B − 1 → B	• • ↕ ↕ 4 •
	DEC				7A 6 3	6A 7 2		M − 1 → M	• • ↕ ↕ 4 •
Decrement stack pointer	DES	34 4 1						SP − 1 → SP	• • • • • •
Decrement index register	DEX	09 4 1						X − 1 → X	• • • ↕ • •
Complement (1's)	COMA	43 2 1						$\overline{A}$ → A	• • ↕ ↕ R S
	COMB	53 2 1						$\overline{B}$ → B	• • ↕ ↕ R S
	COM				73 6 3	63 7 2		$\overline{M}$ → M	• • ↕ ↕ R S
Complement (2's)	NEGA	40 2 1						00 − A → A	• • ↕ ↕ 1 2
	NEGB	50 2 1						00 − B → B	• • ↕ ↕ 1 2
	NEG				70 6 3	60 7 2		00 − M → M	• • ↕ ↕ 1 2
Decimal adjust accumulator	DAA	19 2 1							• • ↕ ↕ ↕ 3

OP = Operation Code MC = Number of MPU Cycles PB = Number of Program Bytes

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FIGURE 9 S6800 INSTRUCTION SET (CONT'D)

		Addressing Mode							Condition Reg
		Implied	Immediate	Direct	Extended	Indexed	Relative	Boolean/Arith	5 4 3 2 1 0
Instruction	Mnemonic	OP MC PB	OP MC PB	OP MC PB	OP MC PB	OP MC PB	OP MC PB	Operation	H I N Z V C
Logical and	ANDA		84 2 2	94 3 2	B4 4 3	A4 5 2		A • M → A	• • ‡ ‡ R •
	ANDB		C4 2 2	D4 3 2	F4 4 3	E4 5 2		B • M → B	• • ‡ ‡ R •
Inclusive or	ORAA		8A 2 2	9A 3 2	BA 4 3	AA 5 2		A + M → A	• • ‡ ‡ R •
	ORAB		CA 2 2	DA 3 2	FA 4 3	EA 5 2		B + M → B	• • ‡ ‡ R •
Exclusive or	EORA		88 2 2	98 3 2	B8 4 3	A8 5 2		A ⊕ M → A	• • ‡ ‡ R •
	EORB		C8 2 2	D8 3 2	F8 4 3	E8 5 2		B ⊕ M → B	• • ‡ ‡ R •
Shift left arithmetic	ASLA	48 2 1						A, B, M ⟨ C b7 b0 ← 0	• • ‡ ‡ 6 ‡
	ASLB	58 2 1							• • ‡ ‡ 6 ‡
	ASL				78 6 3	68 7 2			• • ‡ ‡ 6 ‡
Shift right arithmetic	ASRA	47 2 1						A, B, M ⟨ b7 b0 → C	• • ‡ ‡ 6 ‡
	ASRB	57 2 1							• • ‡ ‡ 6 ‡
	ASR				77 6 3	67 7 2			• • ‡ ‡ 6 ‡
Shift right logical	LSRA	44 2 1						A, B, M ⟨ 0 → b7 b0 → C	• • R ‡ 6 ‡
	LSRB	54 2 1							• • R ‡ 6 ‡
	LSR				74 6 3	64 7 2			• • R ‡ 6 ‡
Rotate left	ROLA	49 2 1						A, B, M ⟨ C ← b7 b0	• • ‡ ‡ 6 ‡
	ROLB	59 2 1							• • ‡ ‡ 6 ‡
	ROL				79 6 3	69 7 2			• • ‡ ‡ 6 ‡
Rotate right	RORA	46 2 1						A, B, M ⟨ C → b7 b0	• • ‡ ‡ 6 ‡
	RORB	56 2 1							• • ‡ ‡ 6 ‡
	ROR				76 6 3	66 7 2			• • ‡ ‡ 6 ‡
Compare accumulators	CBA	11 2 1						A – B	• • ‡ ‡ ‡ ‡
Compare	CMPA		81 2 2	91 3 2	B1 4 3	A1 5 2		A – M	• • ‡ ‡ ‡ ‡
	CMPB		C1 2 2	D1 3 2	F1 4 3	E1 5 2		B – M	• • ‡ ‡ ‡ ‡
Compare index register	CPX		8C 3 3	9C 4 2	BC 5 3	AC 6 2		X_H – M, X_L – (M+1)	• • 7 ‡ 8 •
Test (zero or minus)	TSTA	4D 2 1						A – 00	• • ‡ ‡ R R
	TSTB	5D 2 1						B – 00	• • ‡ ‡ R R
	TST				7D 6 3	6D 7 2		M – 00	• • ‡ ‡ R R
Bit test	BITA		85 2 2	95 3 2	B5 4 3	A5 5 2		A • M	• • ‡ ‡ R •
	BITB		C5 2 2	D5 3 2	F5 4 3	E5 5 2		B • M	• • ‡ ‡ R •
								TEST	
Branch	BRA						20 4 2		• • • • • •
Branch if carry clear	BCC						24 4 2	C = 0	• • • • • •
Branch if carry set	BCS						25 4 2	C = 1	• • • • • •
Branch if overflow clear	BVC						28 4 2	V = 0	• • • • • •
Branch if overflow set	BVS						29 4 2	V = 1	• • • • • •
Branch if equal to zero	BEQ						27 4 2	Z = 1	• • • • • •
Branch if greater or equal to zero	BGE						2C 4 2	N ⊕ V = 0	• • • • • •
Branch if greater than zero	BGT						2E 4 2	Z + (N ⊕ V) = 0	• • • • • •
Branch if less than zero	BLT						2D 4 2	N ⊕ V = 1	• • • • • •
Branch if less than or equal to zero	BLE						2F 4 2	Z + (N ⊕ V) = 1	• • • • • •
Branch if not equal to zero	BNE						26 4 2	Z = 0	• • • • • •
Branch if minus	BMI						2B 4 2	N = 1	• • • • • •
Branch if plus	BPL						2A 4 2	N = 0	• • • • • •
Branch if higher	BHI						22 4 2	C + Z = 0	• • • • • •
Branch if lower or same	BLS						23 4 2	C + Z = 1	• • • • • •

OP = Operation Code MC = Number of MPU Cycles PB = Number of Program Bytes

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FIGURE 9 S6800 INSTRUCTION SET (CONT'D)

		Addressing Modes							Condition Reg.
		Implied	Direct	Immediate	Extended	Indexed	Relative	Boolean/Arith	5 4 3 2 1 0
Instruction	Mnemonic	OP MC PB	OP MC PB	OP MC PB	OP MC PB	OP MC PB	OP MC PB	Operation	H I N Z V C
Branch to subroutine	BSR						8D 8 2		• • • • • •
Jump to subroutine	JSR				BD 9 3	AD 8 2		See Special Operations	• • • • • •
Jump	JMP				7E 3 3	6E 4 2			• • • • • •
Return from subroutine	RTS	39 5 1							• • • • • •
Return from interrupt	RTI	3B 10 1							Note 10
Software interrupt	SWI	3F 12 1							• S • • • •
Wait for interrupt	WAI	3E 9 1							• ‡ • • • •
No operation	NOP	02 2 1						PC + 1 → PC	• • • • • •
Clear	CLRA	4F 2 1						00 → A	• • R S R R
	CLRB	5F 2 1						00 → B	• • R S R R
	CLR				7F 6 3	6F 7 2		00 → M	• • R S R R
Clear carry	CLC	0C 2 1						0 → C	• • • • • R
Clear interrupt mask	CLI	0E 2 1						0 → I	• R • • • •
Clear overflow	CLV	0A 2 1						0 → V	• • • • R •
Set carry	SEC	0D 2 1						1 → C	• • • • • S
Set interrupt mask	SEI	0F 2 1						1 → I	• S • • • •
Set overflow	SEV	0B 2 1						1 → V	• • • • S •

CONDITION CODE SYMBOLS:

H	Half-carry from bit 3;
I	Interrupt mask
N	Negative (sign bit)
Z	Zero (byte)
V	Overflow, 2's complement
C	Carry from bit 7
R	Reset Always
S	Set Always
‡	Test and set if true, cleared otherwise
•	Not Affected

LEGEND:

OP	Operation Code (Hexadecimal):
MC	Number of MPU Cycles;
PB	Number of Program Bytes;
+	Arithmetic Plus;
–	Arithmetic Minus;
•	Boolean AND;
M_{SP}	Contents of memory location pointed to by Stack Pointer;
+	Boolean Inclusive OR;
⊕	Boolean Exclusive OR;
$\bar{M}$	Complement of M;
→	Transfer Into;
0	Bit = Zero;
00	Byte = Zero;

Note – Accumulator addressing mode instructions are included in the IMPLIED addressing.

CONDITION CODE REGISTER NOTES:

(Bit set if test is true and cleared otherwise)

1	(Bit V)	Test: Result = 10000000?
2	(Bit C)	Test: Result = 00000000?
3	(Bit C)	Test: Decimal value of most significant BCD Character greater than nine? (Not cleared if previously set.)
4	(Bit V)	Test: Operand = 10000000 prior to execution?
5	(Bit V)	Test: Operand = 01111111 prior to execution?
6	(Bit V)	Test: Set equal to result of N ⊕ C after shift has occurred.
7	(Bit N)	Test: Sign bit of most significant (MS) byte = 1?
8	(Bit V)	Test: 2's complement overflow from subtraction of MS bytes?
9	(Bit N)	Test: Result less than zero? (Bit 15 = 1)
10	(All)	Load Condition Code Register from Stack. (See Special Operations)
11	(Bit I)	Set when interrupt occurs, if previously set, a Non-Maskable Interrupt is required to exit the wait state.
12	(ALL)	Set according to the contents of Accumulator A

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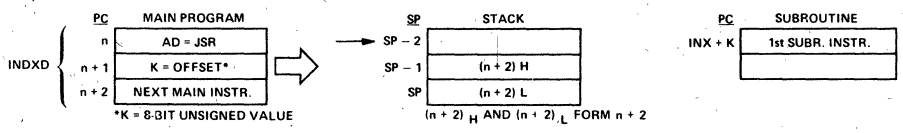
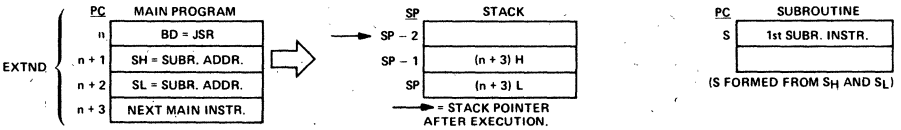
SPECIAL OPERATIONS

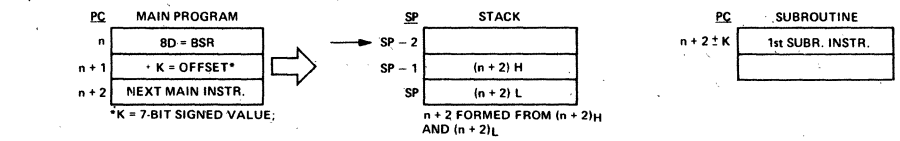
JMP, JUMP:

JSR, JUMP TO SUBROUTINE:

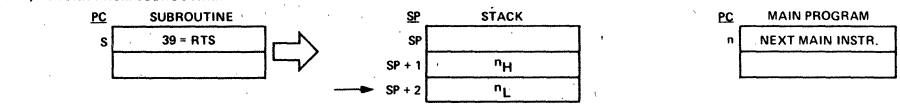




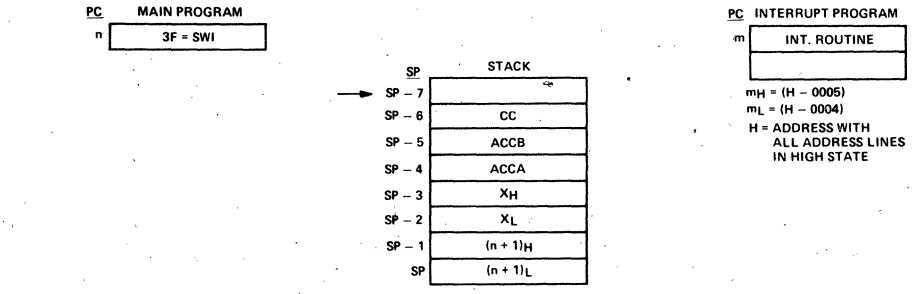
BSR, BRANCH TO SUBROUTINE:



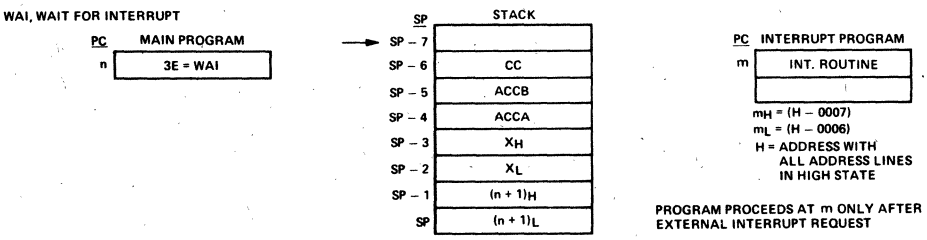
RTS, RETURN FROM SUBROUTINE:



SWI, SOFTWARE INTERRUPT

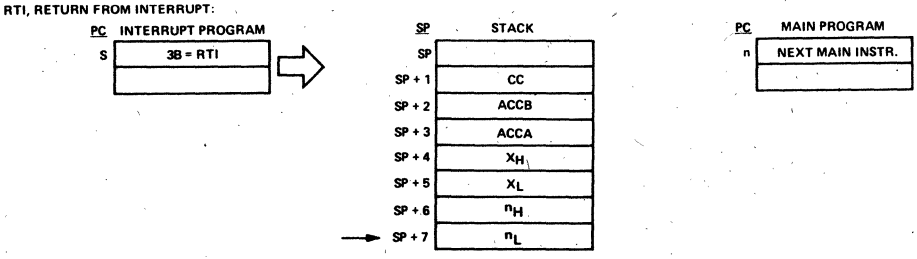


WAI, WAIT FOR INTERRUPT



PROGRAM PROCEEDS AT m ONLY AFTER EXTERNAL INTERRUPT REQUEST

RTI, RETURN FROM INTERRUPT:



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SYSTEMS OPERATION

To demonstrate the great versatility of the functional building block concept, a typical system configuration is shown. This configuration will demonstrate how easily a basic system may be upgraded and expanded for a number of different applications.

The Microprocessing Unit (MPU) may be configured with a Read Only Memory (ROM), Random Access Memory (RAM), a Peripheral Interface Adapter (PIA), restart circuitry and clock circuitry to form a minimum functional system (Figure 10). Such a system can easily be adapted for a number of small scale applications by simply changing the content of the ROM.

TWO-PHASE CLOCK CIRCUITRY AND TIMING–The MPU requires a two-phase non-overlapping clock which has a frequency range as high as 1 MHz. In addition to the two phases, this circuit should also generate an enable signal E, and its complement $\overline{E}$, to enable ROMs, RAMs, PIAs and ACIAs. This Enable signal and its complement is obtained by ANDing $\phi 2$ and VMA (Valid Memory Address).

CHIP SELECTION AND ADDRESSING–The minimum system configuration permits direct selection of the ROM, RAM, ACIA and PIA without the use of special TTL select logic. This is accomplished by simply wiring the address lines A13 and A14 to the Enable or chip select lines on the memories and PIA. This permits the devices to be addressed as follows:

Device	A14	A13	Hex Addresses
RAM	0	0	0000–007F
PIA	0	1	2004–2007 (Registers)
ROM	1	1	6000–63FF

Other addressing schemes can be utilized which use any combination of two of the lines A10 through A14 for chip selection.

PERIPHERAL CONTROL–All control and timing for the peripherals that are connected to the PIA is accomplished by software routines under the control of the MPU.

RESTART AND NON-MASKABLE INTERRUPT–Since this basic system does not have a nonvolatile RAM, special circuitry to handle loss of power using NMI is not required. Circuitry is, however, required to insure proper initialization of the MPU when power is turned on. This circuit should insure that the Restart signal is held low for eight $\phi 1$ clock cycles after the V_{CC} power supply reaches a voltage of approximately 4.75 volts DC. Also, in order to insure that a PIA or ACIA is not inadvertently selected during the power-on sequence, Three-State Control (TSC) should be held high until the positive transition of Restart.

$\overline{HALT}$–The $\overline{Halt}$ line is tied to V_{CC} and will automatically place the MPU in the run state when power is turned on. This signal may be used to halt the MPU if a switch is used to tie the line to ground for HALT and to V_{CC} for RUN.

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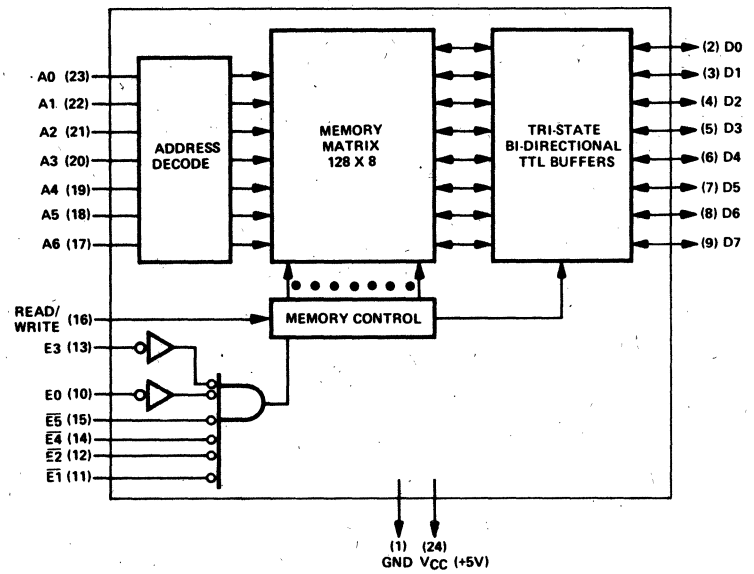
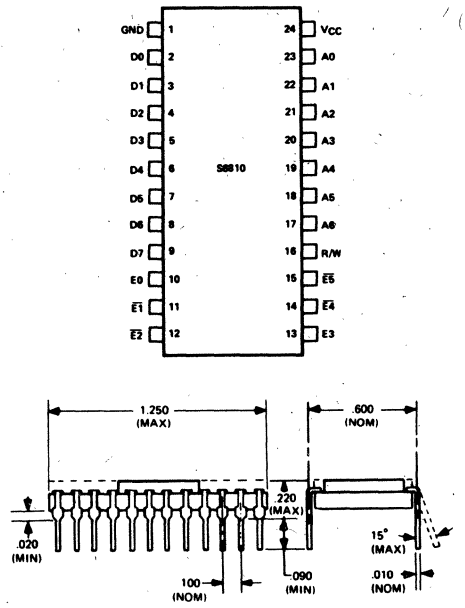
S6810

128 X 8 STATIC
READ/WRITE MEMORY

AMERICAN MICROSYSTEMS, INC.



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- Organized as 128 Bytes of 8 Bits
- Static Operation
- Bi-Directional Three-State Data Input/Output
- Six Chip Enable Inputs (Four Active Low, Two Active High)
- Single 5-Volt Power Supply
- TTL Compatible
- Maximum Access Time = 1.0μs for S6810
  575 ns for S6810-1

FUNCTIONAL DESCRIPTION

The S6810 is a static 128 x 8 Read/Write Memory designed and organized to be compatible with the S6800 Microprocessor. Interfacing to the S6810 consists of an 8 Bit Bi-directional Data Bus, Seven Address Lines, a single Read/Write Control line, and six Chip Enable lines, four negative and two positive.

For ease of use, the S6810 is a totally static memory requiring no clocks or cell refresh. The S6810 is fabricated with N channel silicon gate technology to be fully DTL/TTL compatible with only a single +5 volt power supply required.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC}	-0.3 to +7.0V
Input Voltage V_{in}	-0.3 to +7.0V
Operating Temperature Range T_A	0 to +70°C
Storage Temperature Range T_{stg}	-55 to +150°C

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DC (STATIC) CHARACTERISTICS

(V_{CC} = 5.0 Volt ± 5%; T_A = 25°C unless otherwise noted)

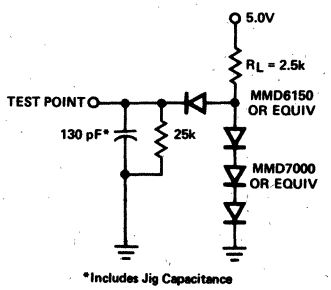
Characteristic	Symbol	Min.	Typ.	Max.	Unit	Condition
Input High Voltage(NormalOperatingLevels)	V_{IH}	2.4	–	5.25	V	
Input Low Voltage(NormalOperating Levels)	V_{IL}	-0.3	–	0.4	V	
Input Current (A_n, R/W, E_n, $\overline{E}_n$) (V_{in} = 0 to 5.25 V)	I_{in}	–	–	2.5	μA	
Input High Threshold Voltage	V_{IHT}	2.0	–	–	V	
Input Low Threshold Voltage	V_{ILT}	–	–	0.8	V	
Output High Voltage (I_{OH} = -100 μA)	V_{OH}	2.4	–	–	V	
Output Low Voltage (I_{OL} = 1.6 mA)	V_{OL}	–	–	0.4	V	
Output Leakage Current (D0 – D7) (V_O = 2.4 V, E = 0.4 V, $\overline{E}$ = 2.4 V)	I_{LIH}	–	–	10	μA	
Output Leakage Current (D0 – D7) (V_O = 0.4 V, E = 0.4 V, $\overline{E}$ = 2.4 V)	I_{LOL}	–	–	10	μA	
Supply Current (V_{CC} = 5.25 V, T_A = 0°C)	I_{CC}	–	–	130	mA	
Input Capacitance	C_{IN}	–	–	7.5	pF	f = 1.0MHz, T_A = 25°C
Output Capacitance	C_{OUT}	–	–	15	pF	

AC (DYNAMIC) CHARACTERISTICS

(V_{CC} = 5.0 Volt ∓ 5%, T_A = 0°C to + 70°C)

Characteristic		Symbol	Min.	Max.	Unit
Address Setup Time		t_{AS}	30	–	ns
Address Hold Time		t_{AH}	0	–	ns
Chip Enable Pulse Width	S6810 S6810-1	t_{CS}	800 400	–	ns

FIGURE 1 – AC TEST LOAD



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READ CYCLE

(All timing with $t_r = t_f = 20$ ns, Load of Figure 1)

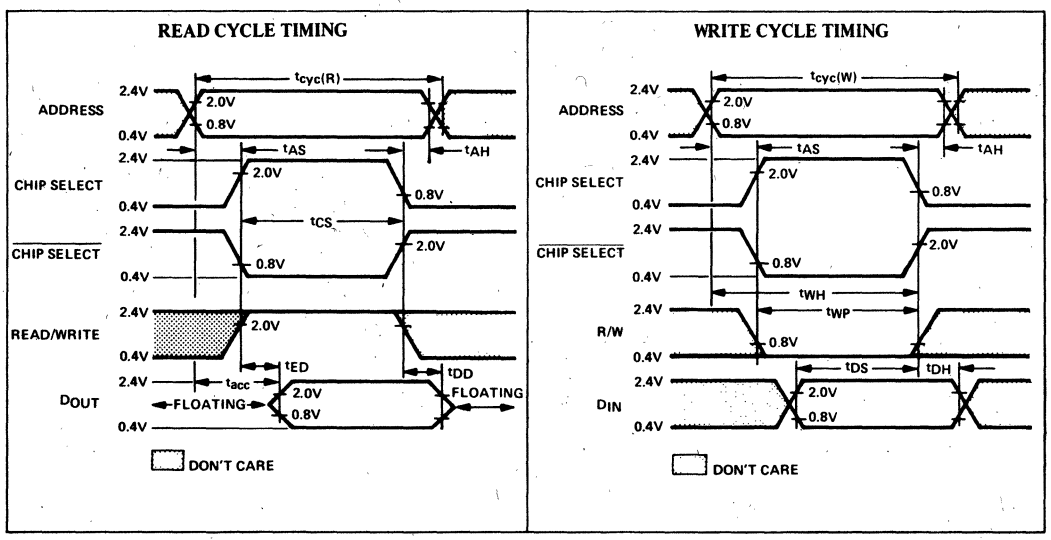
Characteristic		Symbol	Min.	Max.	Unit
Read Cycle Time	S6810	$t_{cyc(R)}$	1000	–	ns
	S6810-1		575	–	ns
Output Enable Delay Time	S6810	t_{ED}	–	400	ns
	S6810-1		–	300	ns
Output Disable Delay Time	S6810	t_{DD}	10	200	ns
	S6810-1		10	150	ns
Read Access Time	S6810	t_{acc}	–	1000	ns
	S6810-1		–	575	ns

WRITE CYCLE

(All timing with $t_r = t_f = 20$ ns, Load of Figure 1)

Characteristic		Symbol	Min.	Max.	Unit
Write Cycle Time	S6810	$t_{cyc(W)}$	1000	–	ns
	S6810-1		500	–	ns
Write Pulse Width	S6810	t_{WP}	800	–	ns
	S6810-1		400	–	ns
Write Pulse Hold Time	S6810	t_{WH}	1000	–	ns
	S6810-1		500	–	ns
Data Setup Time	S6810	t_{DS}	500	–	ns
	S6810-1		300	–	ns
Data Hold Time	S6810	t_{DH}	0	–	ns
	S6810-1				

TIMING CHARACTERISTICS



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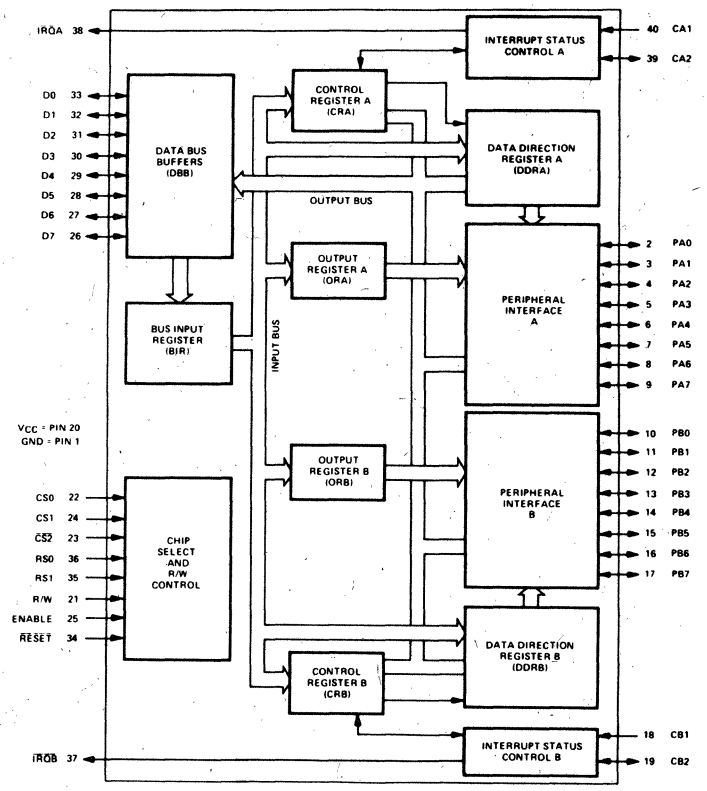
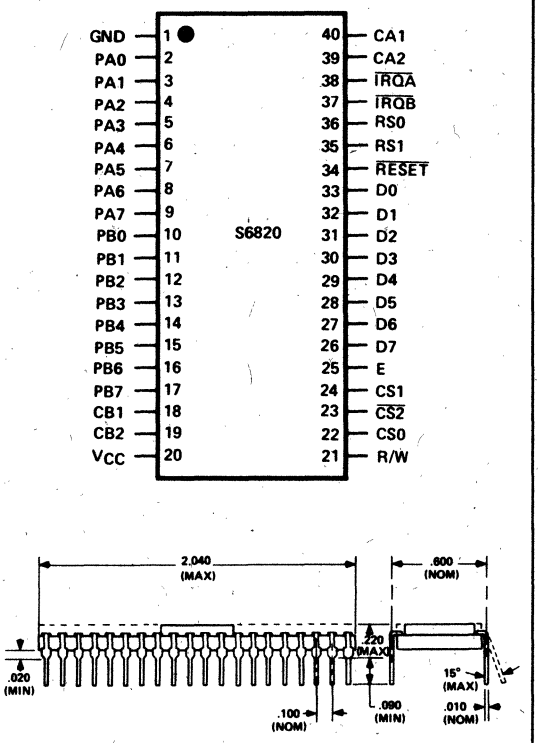
S6820

PERIPHERAL INTERFACE
ADAPTER (PIA)



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- 8-Bit Bidirectional Data Bus for Communication with the MPU
- Two Bidirectional 8-Bit Buses for Interface to Peripherals
- Two Programmable Control Registers
- Two Programmable Data Direction Registers
- Four Individually-Controlled Interrupt Input Lines; Two Usable as Peripheral Control Outputs
- Handshake Control Logic for Input and Output Peripheral Operation
- High-Impedance 3-State and Direct Transistor Drive Peripheral Lines
- Program Controlled Interrupt and Interrupt Disable Capability
- CMOS Compatible Peripheral Lines

FUNCTIONAL DESCRIPTION

The S6820 Peripheral Interface Adapter provides the universal means of interfacing peripheral equipment to the S6800 Microprocessing Unit (MPU). This device is capable of interfacing the MPU to peripherals through two 8-bit bidirectional peripheral data buses and four control lines. No external logic is required for interfacing to most peripheral devices.

The functional configuration of the PIA is programmed by the MPU during system initialization. Each of the peripheral data lines can be programmed to act as an input or output, and

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FUNCTIONAL DESCRIPTION (CONT'D)

each of the four control/interrupt lines may be programmed for one of several control modes. This allows a high degree of flexibility in the over-all operation of the interface.

The PIA interfaces to the S6800 MPU with an eight-bit bidirectional data bus, three chip select lines, two register select lines, two interrupt request lines, read/write line, enable line and reset line. These signals, in conjunction with the S6800 VMA output, permit the MPU to have complete control over the PIA. VMA may be utilized to gate the input signals to the PIA.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC}	-0.3 to +7.0V
Input Voltage V_{in}	-0.3 to +7.0V
Operating Temperature Range T_A	0 to +70°C
Storage Temperature Range T_{stg}	-55 to +150°C

NOTE: This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields, however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high-impedance circuit.

DC (STATIC) CHARACTERISTICS (V_{CC} = 5.0V ± 5%, T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Input High Voltage (Normal Operating Levels)	V_{IH}	+2.4	–	V_{CC}	Vdc
Input Low Voltage (Normal Operating Levels)	V_{IL}	-0.3	–	+0.4	Vdc
Input High Threshold Voltage — All Inputs Except Enable	V_{IHT}	+2.0	–	–	Vdc
Input Low Threshold Voltage — All Inputs Except Enable	V_{ILT}	–	–	+0.8	Vdc
Input Leakage Current (V_{in} = 0 to 5.0 Vdc) R/W, $\overline{Reset}$, RS0, RS1, CS0, CS1, $\overline{CS2}$, CA1, CB1, Enable	I_{in}	–	1.0	2.5	μAdc
Three-State (Off State) Input Current (V_{in} = 0.4 to 2.4 Vdc, V_{CC} = max) D0-D7, PB0-PB7, CB2	I_{TSI}	–	2.0	10	μAdc
Input High Current (V_{IH} = 2.4 Vdc) PA0-PA7, CA2	I_{IH}	100	250	–	μAdc
Input Low Current (V_{IL} = 0.4 Vdc) PA0-PA7, CA2	I_{IL}	–	1.0	1.6	mAdc
Output High Voltage (V_{CC} = min, I_{Load} = -100 μAdc, Enable Pulse Width < 25 μs)	V_{OH}	+2.4	–	–	Vdc
Output Low Voltage (V_{CC} = min, I_{Load} = 1.6 mAdc)	V_{OL}	–	–	+0.4	Vdc
Output High Current (Sourcing)	I_{OH}				
(V_{OH} = 2.4 Vdc)		-100	-1000	–	μAdc
(V_{OH} = 1.5 Vdc, the current for driving other than TTL, e.g., Darlington Base) PB0-PB7, CB2		-1.0	-2.5	–	mAdc
Output Low Current (Sinking) (V_{OL} = 0.4 Vdc)	I_{OL}	1.6	–	–	mAdc
Output Leakage Current (Off State) $\overline{IRQA}$, $\overline{IRQB}$	I_{off}	–	1.0	10	μAdc
Power Dissipation	P_D	–	300	600	mW
Input Capacitance (V_{in} = 0, T_A = 25°C, f = 1.0 MHz)	C_{in}				pF
D0-D7, PA0-PA7, PB0-PB7, CA2, CB2		–	–	10	
R/W, $\overline{Reset}$, RS0, RS1, CS0, CS1, $\overline{CS2}$, CA1, CB1		–	–	7.0	
Enable		–	–	20	
Output Capacitance (V_{in} = 0, T_A = 25°C, f = 1.0 MHz)	C_{out}	–	–	10	pF

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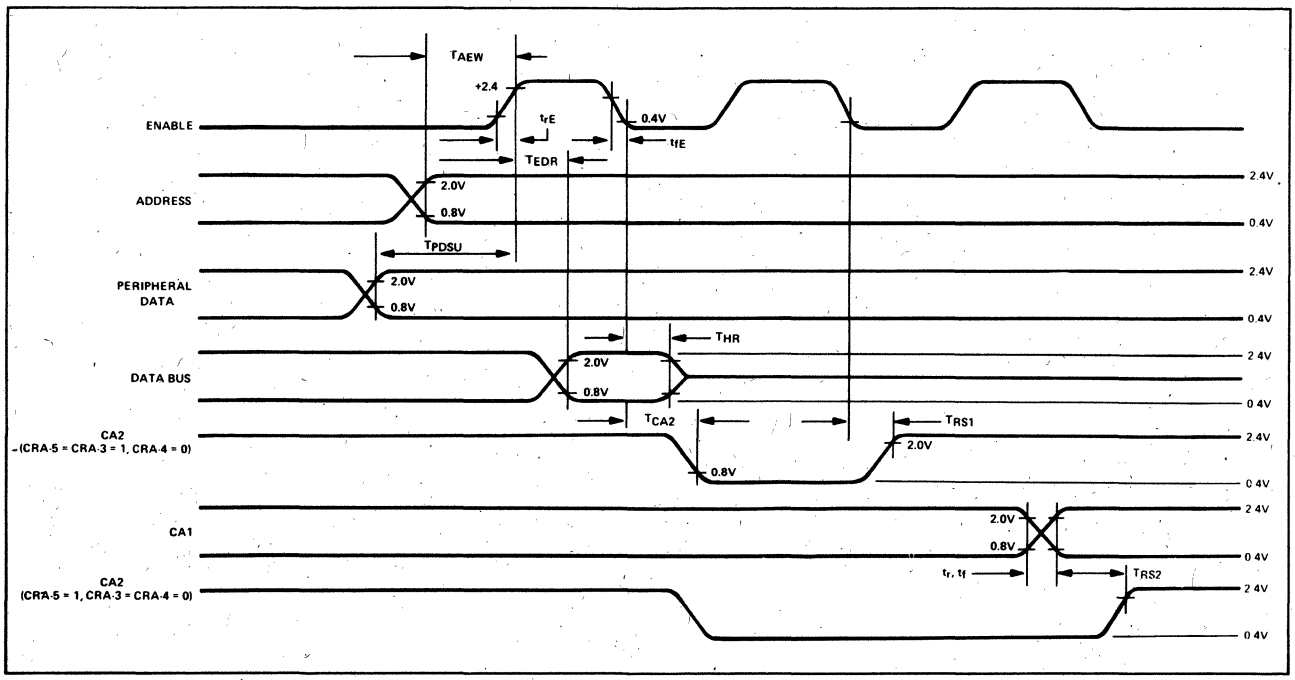
AC (DYNAMIC) CHARACTERISTICS Loading = 30 pF and one TTL load for PA0-PA7, PB0-PB7, CA2, CB2
= 130 pF and one TTL load for D0-D7, $\overline{IRQA}$, $\overline{IRQB}$

READ TIMING CHARACTERISTICS (Figure 1)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Delay Time, Address valid to Enable positive transition	T_{AEW}	180	–	–	ns
Delay Time, Enable positive transition to Data valid on bus	T_{EDR}	–	–	395	ns
Peripheral Data Setup Time	T_{PDSU}	300	–	–	ns
Data Bus Hold Time	T_{HR}	10	–	–	ns
Delay Time, Enable negative transition to CA2 negative transition	T_{CA2}	–	–	1.0	μs
Delay Time, Enable negative transition to CA2 positive transition	T_{RS1}	–	–	1.0	μs
Rise and Fall Time for CA1 and CA2 input signals	t_r, t_f	–	–	1.0	μs
Delay Time from CA1 active transition to CA2 positive transition	T_{RS2}	–	–	2.0	μs
Rise and Fall Time for Enable input	t_{rE}, t_{fE}	–	–	25	μs

FIGURE 1 – READ TIMING CHARACTERISTICS



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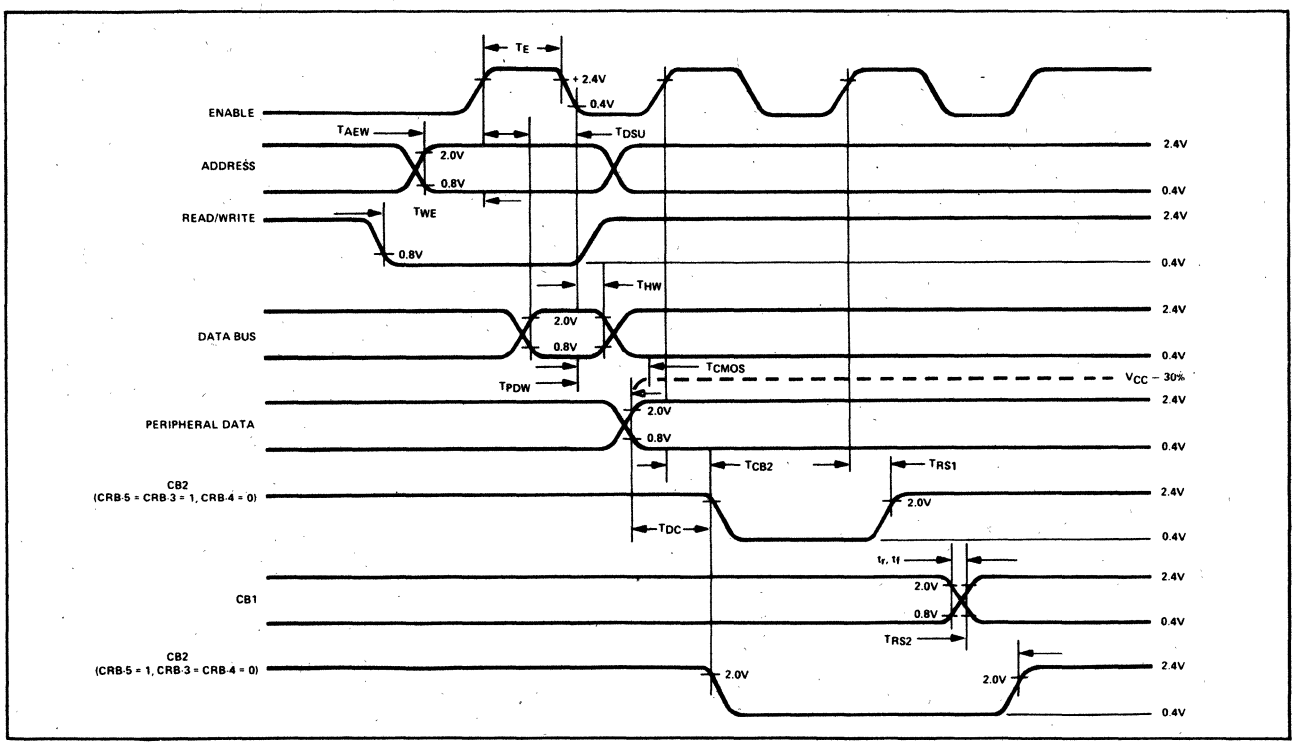
WRITE TIMING CHARACTERISTICS (Figure 2)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Enable Pulse Width	T_E	0.470	–	25	μs
Delay Time, Address valid to Enable positive transition	T_{AEW}	180	–	–	ns
Delay Time, Data valid to Enable negative transition	T_{DSU}	300	–	–	ns
Delay Time, Read/Write negative transition to Enable positive transition	T_{WE}	130	–	–	ns
Data Bus Hold Time.	T_{HW}	10	–	–	ns
Delay Time, Enable negative transition to Peripheral Data valid	T_{PDW}	–	–	1.0	μs
Delay Time, Enable negative transition to Peripheral Data valid, CMOS (V_{CC} - 30%) PA0-PA7, CA2	T_{CMOS}	–	–	2.0	μs
Delay Time, Enable positive transition to CB2 negative transition	T_{CB2}	–	–	1.0	μs
Delay Time, Peripheral Data valid to CB2 negative transition	T_{DC}	0	–	1.5	μs
Delay Time, Enable positive transition to CB2 positive transition	T_{RS1}	–	–	1.0	μs
Rise and Fall Time for CB1 and CB2 input signals	t_r, t_f	–	–	1.0	μs
Delay Time, CB1 active transition to CB2 positive transition	T_{RS2}	–	–	2.0	μs

FIGURE 2 – WRITE TIMING CHARACTERISTICS



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INTERFACE DESCRIPTION

MPU/PIA INTERFACE

Pin	Label	Function
(33) (32) (31) (30) (29) (28) (27) (26)	D0 D1 D2 D3 D4 D5 D6 D7	**Bi-Directional Data** – The bi-directional data lines (D0-D7) allow the transfer of data between the MPU and the PIA. The data bus output drivers are three-state devices that remain in the high-impedance (off) state except when the MPU performs a PIA read operation. The Read/Write line is in the Read (high) state when the PIA is selected for a Read operation.
(25)	E	**Enable** – The enable pulse, E, is the only timing signal that is supplied to the PIA. Timing of all other signals is referenced to the leading and trailing edges of the E pulse. This signal will normally be a derivative of the S6800 $\phi 2$ Clock. The E pulse is used to condition the interrupt/control lines CA1, CA2, CB1, and CB2. At least one E pulse must occur from the inactive edge to the active edge of the input signal to set the interrupt flag, when the lines are used as inputs.
(21)	R/W	**Read/Write** – This signal is generated by the MPU to control the direction of data transfers on the Data Bus. A low state on the PIA Read/Write line enables the input buffers and data is transferred from the MPU to the PIA on the E signal if the device has been selected. A high on the Read/Write line sets up the PIA for a transfer of data to the bus. The PIA output buffers are enabled when the proper address and the enable pulse E are present.
(34)	$\overline{\text{RESET}}$	**Reset** – The active low $\overline{\text{Reset}}$ line is used to reset all register bits in the PIA to a logical zero (low). This line can be used as a power-on reset and as a master reset during system operation.
(22) (24) (23)	CS0 CS1 $\overline{\text{CS2}}$	**Chip Select** – These three input signals are used to select the PIA. CS0 and CS1 must be high and $\overline{\text{CS2}}$ must be low for selection of the device. Data transfers are then performed under the control of the Enable and Read/Write signals. The chip select lines must be stable for the duration of the E pulse.
(36) (35)	RS0 RS1	**PIA Register Select** – The two register select lines are used to select the various registers inside the PIA. These two lines are used in conjunction with internal Control Registers to select a particular register that is to be written or read. The Register select lines should be stable for the duration of the E pulse while in the read or write cycle.
(38) (37)	$\overline{\text{IRQA}}$ $\overline{\text{IRQB}}$	**Interrupt Request** – The active low Interrupt Request lines ($\overline{\text{IRQA}}$ and $\overline{\text{IRQB}}$) act to interrupt the MPU either directly or through interrupt priority circuitry. These lines are "open source" (no load device on the chip) and are capable of sinking a current of 1.6 mA from an external source. This permits all interrupt request lines to be tied together in a wire-OR configuration. Each Interrupt Request line has two internal interrupt flag bits that will cause the Interrupt Request line to go low. Each flag bit is associated with a particular peripheral interrupt line. Also four interrupt enable bits are provided in the PIA which may be used to inhibit a particular interrupt from a peripheral device. Servicing an interrupt by the MPU is accomplished by a software routine that, on a prioritized basis, sequentially reads and tests the two control registers in each PIA for interrupt flag bits that are set. The Interrupt Flag is cleared (zeroed) as a result of an MPU Read Peripheral Data Operation.

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PIA/PERIPHERAL INTERFACE

Pin	Label	Function
(2) (3) (4) (5) (6) (7) (8) (9)	PA0 PA1 PA2 PA3 PA4 PA5 PA6 PA7	**Section A Peripheral Data** – Each of the peripheral data lines can be programmed to act as an input or output. This is accomplished by setting a "1" in the corresponding Data Direction Register bit for those lines which are to be outputs. A "0" in a bit of the Data Direction Register causes the corresponding peripheral data line to act as an input. During an MPU Read Peripheral Data Operation, the data on peripheral lines programmed to act as inputs appears directly on the corresponding MPU Data Bus lines. In the input mode the internal pullup resistor on these lines represents a maximum of one standard TTL load. The data in Output Register A will appear on the data lines that are programmed to be outputs. A logical "1" written into the register will cause a "high" on the corresponding data line while a "0" results in a "low". Data in Output Register A may be read by an MPU "Read Peripheral Data A" operation when the corresponding lines are programmed as outputs. This data will be read properly if the voltage on the peripheral data lines is greater than 2.0 volts for a logic "1" output and less than 0.8 volt for a logic "0" output. Loading the output lines such that the voltage on these lines does not reach full voltage causes the data transferred into the MPU on a Read operation to differ from that contained in the respective bit of Output Register A.
(10) (11) (12) (13) (14) (15) (16) (17)	PB0 PB1 PB2 PB3 PB4 PB5 PB6 PB7	**Section B Peripheral Data** – The peripheral data lines in the B Section of the PIA can be programmed to act as either inputs or outputs in a similar manner to PA0-PA7. However, the output buffers driving these lines differ from those driving lines PA0-PA7. They have three-state capability, allowing them to enter a high impedance state when the peripheral data line is used as an input. In addition, data on the peripheral data lines PB0-PB7 will be read properly from those lines programmed as outputs even if the voltages are below 2.0 volts for a "high". As outputs, these lines are compatible with standard TTL and may also be used as a source of up to 1 milliampere at 1.5 volts to directly drive the base of a transistor switch.
(40) (18)	CA1 CB1	**Interrupt Input** – Peripheral Input lines CA1 and CB1 are input-only lines that set the interrupt flags of the control registers. The active transition for these signals is also programmed by the two control registers.
(39)	CA2	**Peripheral Control** – The peripheral control line CA2 can be programmed to act as an interrupt input or as a peripheral control output. As an output, this line is compatible with standard TTL; as an input the internal pullup resistor on this line represents one standard TTL load. The function of this signal line is programmed with Control Register A.
(19)	CB2	**Peripheral Control** – Peripheral Control line CB2 may also be programmed to act as an interrupt input or peripheral control output. As an input, this line has high input impedance and is compatible with standard TTL. As an output it is compatible with standard TTL and may also be used as a source of up to 1 milliampere at 1.5 volts to directly drive the base of a transistor switch. This line is programmed by Control Register B.
(1)	GND	**Ground**
(20)	V_{CC}	+5 Volts ± 5%

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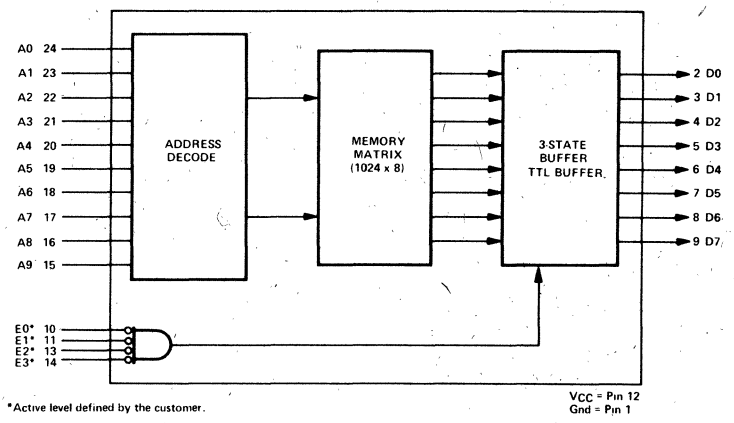
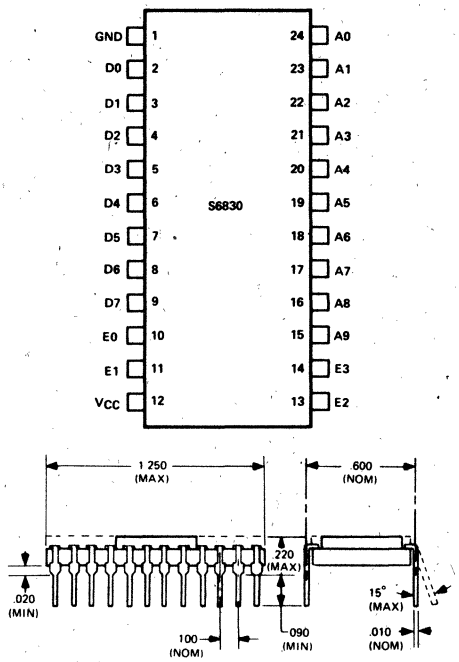
S6830

1024 X 8
READ ONLY MEMORY



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- Organized as 1024-Bytes of 8 Bits
- Static Operation
- Three-State Data Output
- Four Chip Enable Inputs (Mask Programmable)
- Single 5-Volt Power Supply
- TTL Compatible Input/Output
- Maximum Access Time = 575 ns

FUNCTIONAL DESCRIPTION

The S6830 is a mask programmable read only memory organized 1024 words x 8 bits for application in byte organized systems. The S6830 is totally bus compatible with the S6800 microprocessor. Interfacing to the S6830 consists of an 8 bit three-state data bus, four mask programmable chip selects and ten address lines.

The S6830 is a totally static memory requiring no clocks. Access time is compatible with maximum data rates in a S6800 microprocessor system. The device operates from a single +5 volt power supply and is fabricated with N channel silicon gate technology.

ABSOLUTE MAXIMUM RATINGS (See Note 1)

Supply Voltage V_{CC}	-0.3 to +7.0V
Input Voltage V_{in}	-0.3 to +7.0V
Operating Temperature Range T_A	0 to +70°C
Storage Temperature Range T_{stg}	-55 to +150°C

NOTE: 1. Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended voltages for extended periods of time could affect device reliability.

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DC (STATIC) CHARACTERISTICS

(V_{CC} = +5 Volt ±5%; T_A = 0°C to +70°C) **RECOMMENDED DC OPERATING CONDITIONS**

Parameter	Symbol	Min.	Max.	Unit
Input High Voltage (Norm. Op. Levels)	V_{IH}	2.4	5.25	Vdc
Input Low Voltage (Norm. Op. Levels)	V_{IL}	-0.3	0.4	Vdc
Input Current (V_{in} = 0 to 5.25 V)	I_{in}	–	2.5	μAdc
Input High Threshold Voltage	V_{IHT}	2.0	–	Vdc
Input Low Threshold Voltage	V_{ILT}	–	0.65	Vdc
Output High Voltage (I_{OH} = -100 μA)	V_{OH}	2.4	–	Vdc
Output Low Voltage (I_{OL} = 1.6 mA)	V_{OL}	–	0.45	Vdc
Output Leakage Current (V_{OH} = 2.4 V, E = 0.4 V, $\overline{E}$ = 2.4 V)	I_{LOH}	–	10	μAdc
Output Leakage Current (V_{OH} = 0.4 V, E = 0.4 V, $\overline{E}$ = 2.4 V)	I_{LOL}	–	10	μAdc
Supply Current (V_{CC} @ 5.25V, T_A = 0°C)	I_{CC}	–	130	mAdc

CAPACITANCE

Characteristic	Symbol	Min.	Typ.	Max.	Unit	Conditions
Input Capacitance	C_{in}	–	–	7.5	pF	f = 1.0 MHz
Output Capacitance	C_{out}	–	–	15	pF	T_A = 25°C

AC (DYNAMIC) CHARACTERISTICS READ CYCLE (All timing with $t_r = t_f$ = 20 ns, Load of Figure 1)

V_{CC} = +5 Volt ± 5%; T_A = 0°C to +70°C

Characteristic	Symbol	Min.	Max.	Unit
Read Cycle Time	t_{cyc} (R)	575	–	ns
Output Enable Delay Time	t_{ED}	–	300	ns
Output Disable Delay Time	t_{DD}	10	150	ns
Read Access Time	t_{acc}	–	575	ns

READ CYCLE TIMING

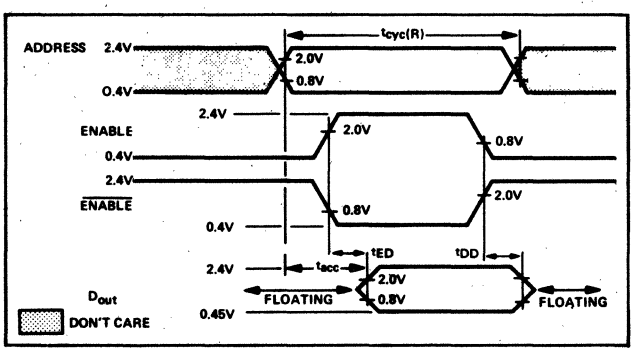
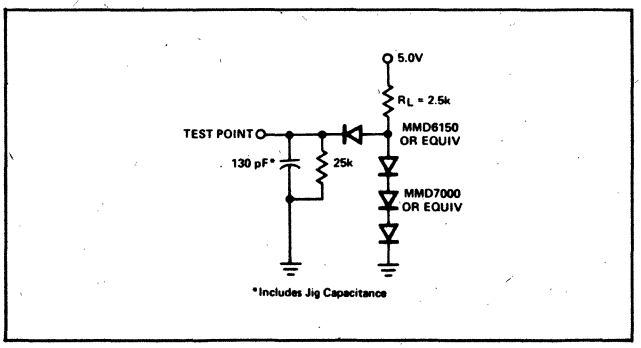


FIGURE 1 – AC TEST LOAD



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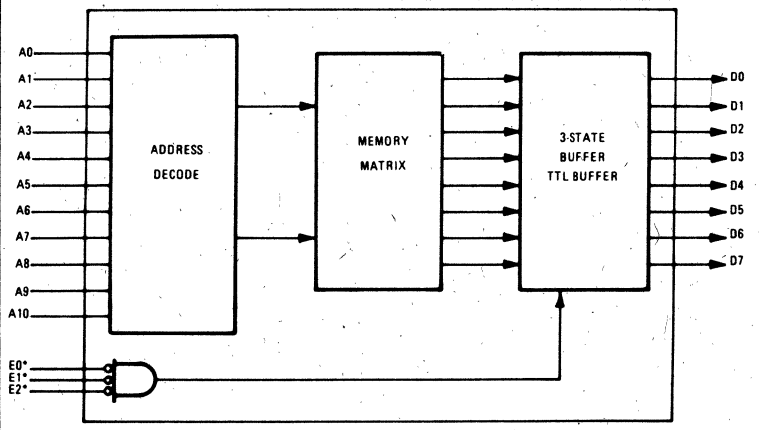
S6831/A/B/C

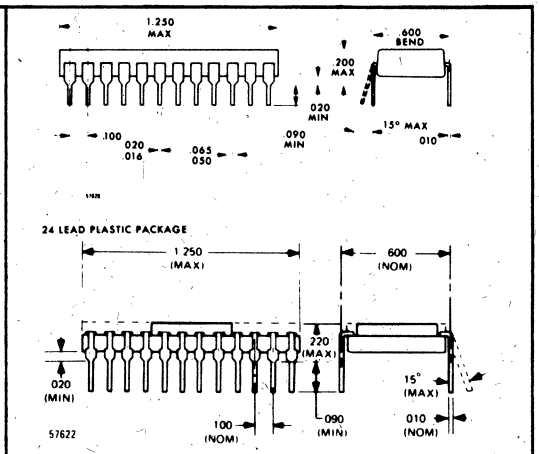
2048 X 8
READ ONLY MEMORY

AMERICAN MICROSYSTEMS, INC.

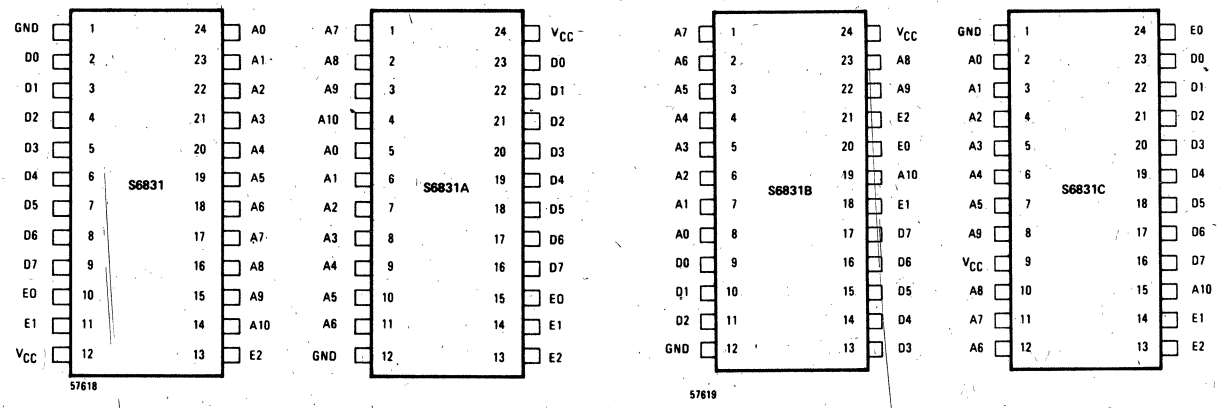
ADVANCED PRODUCT DESCRIPTION



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION



- Maximum Access Time = 450 ns @ C_L = 130 pF
- Low Power 150 mW avg.
- Organized as 2048-Bytes of 8 Bits
- Static Operation
- Three-State Data Output
- 3 Chip Enable Inputs (Mask Programmable)
- The S6831 is pinout similar with the S6830
- The S6831A is pinout compatible with the 2316A, 8316A
- The S6831B is pinout compatible with the Intel 2316B, MC68317
- The S6831C is pinout compatible with the EA4600
- Single 5-Volt Power Supply
- TTL Compatible Input/Output

FUNCTIONAL DESCRIPTION

The S6831/A/B/C is a 16,384 bit Read Only Memory organized 2K words x 8 bits. This ROM has been designed to supply large bit storage, high performance memory for microprocessors and other demanding applications with simple interface requirements. The device will operate from a single +5V supply and is manufactured with a N-channel silicon gate depletion load technology. This device is available in all common high density ROM pinouts.

ABSOLUTE MAXIMUM RATINGS (See Note 1)

Supply Voltage V_{CC}	- 0.5 to + 7.0V	Operating Temperature Range T_A	0 to + 70°C
Input Voltage V_{in}	- 0.5 to + 7.0V	Storage Temperature Range T_{stg}	- 55 to + 150°C

NOTE 1 *Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended voltages for extended periods of time could affect device reliability.*

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DC (STATIC) CHARACTERISTICS (V_{CC} = + 5 Volt ± 5%; T_A = 0°C to + 70°C)

RECOMMENDED DC OPERATING CONDITIONS

Symbol	Parameter	Min.	Typ.	Max.	Unit	Conditions
V_{IH}	Input High Voltage (Norm. Op. Levels)	2.0	–	5.25	Vdc	
V_{IL}	Input Low Voltage (Norm. Op. Levels)	- 0.5	–	0.8	Vdc	
I_I	Input Current (V_I = 0 to 5.25 V)	–	–	2.5	μAdc	
V_{OH}	Output High Voltage (I_{OH} =-100μA)	2.4	–	–	Vdc	
V_{OL}	Output Low Voltage (I_{OL} = 2.1 mA)	–	–	0.4	Vdc	
I_{LOH}	Output Leakage Current (V_O = 2.4, $\overline{E}$ = 0.4V, E = 2.4V)	–	–	10	μAdc	
I_{LOL}	Output Leakage Current (V_O = 0.4V, $\overline{E}$ = 0.4V, E = 2.4V)	–	–	10	μAdc	
I_{CC}	Supply Current (V_{CC} = 5.25V, T_A = 0°C)	–	30		mAdc	

CAPACITANCE

Symbol	Characteristic	Min.	Typ.	Max	Unit	Conditions
C_{in}	Input Capacitance	–	–	7.5	pF	f = 1.0 MHz
C_{out}	Output Capacitance	–	–	10	pF	T_A = 25°C

AC (DYNAMIC) CHARACTERISTICS V_{CC} = + 5 Volt ± 5%; T_A = 0°C to + 70°C

READ CYCLE (All timing with $t_r = t_f$ = 20 ns, Load of Figure 1)

Symbol	Characteristic	Min.	Max.	Unit
t_{cyc} (R)	Read Cycle Time	450	–	ns
t_{ED}	Output Enable Delay Time	–	200	ns
t_{DD}	Output Disable Delay Time	10	150	ns
t_{ACC}	Read Access Time	–	450	ns

READ CYCLE TIMING

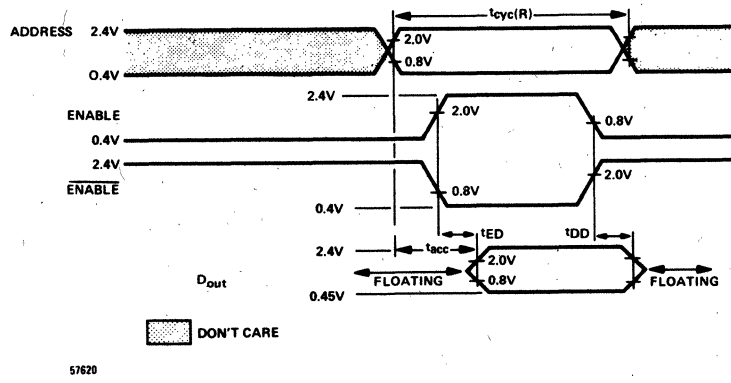

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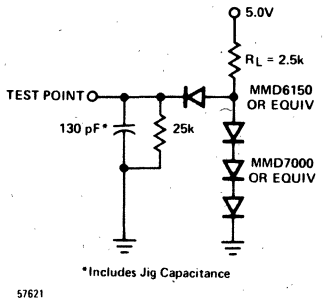
FIGURE 1 – AC TEST LOAD



CUSTOM PROGRAMMING

The preferred method of pattern submission is the AMI Hex format as described below with its built-in address space mapping and error checking. This is the format produced by the AMI Assembler/Loader. The format is as follows and may be on paper tape, punched card or other media readable by AMI.

ASCII Character	Description
1	**Start of record** (S)
2	**Type of record** 0 – Header record 1 – Data record 9 – End of file record
3 – 4	**Byte Count** Since each data byte is represented as two hex characters, the byte count must be multiplied by two fo get the number of characters to the end of the record. (This includes checksum and address data.) Records may be of any length being defined in each record by the byte count.
5, 6, 7, 8	**Address Value** The memory location where this record is to be stored.
9, . . . , N	**Data** Each data byte is represented by two hex characters. Most significant character first.
N + 1, N + 2	**Checksum** The one's complement of the additive summation (without carry) of the data bytes, the address, and the byte count.

AMI will accept the input format used for the EA4600 or for the Intel 8316A or B in addition to the above format.

EXAMPLE:

```
S 1 1 3 0 0 0 0 0 4 9 E 9 F 1 0 3 2 0 F 0 4 9 3 1 3 9 F 7 2 0 0 0 F 5 E 0 F 0 0 1 1 D
S 9 0 3 0 0 0 0 F C
```

START OF RECORD
TYPE OF RECORD
BYTE COUNT (HEX)
START ADDRESS
DATA
CHECK SUM

```
S 1 1 3 0 0 0 0 0 4 9 E 9 F 1 0 3 2 0 F 0 4 9 3 1 3 9 F 7 2 0 0 0 F 5 E 0 F 0 0 1 1 D
```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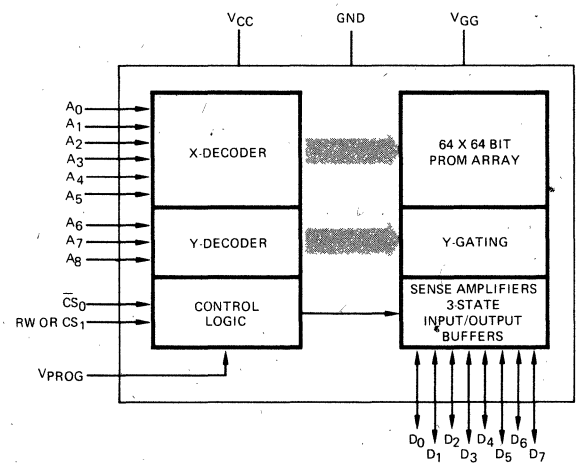
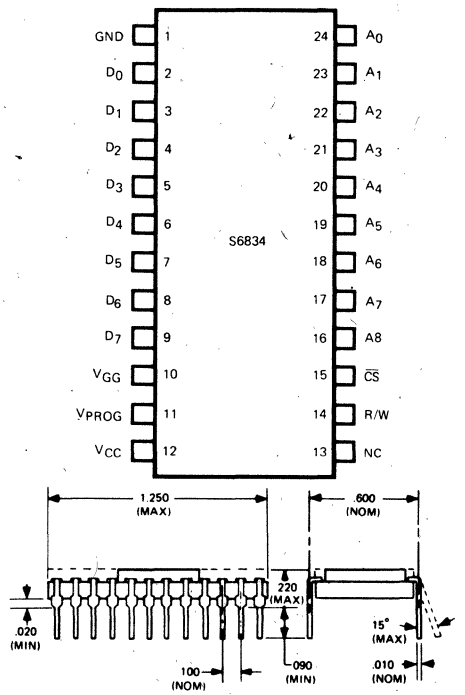
S6834

512 X 8 BIT
ERASEABLE AND
ELECTRICALLY REPROGRAMMABLE
READ ONLY MEMORY

AMERICAN MICROSYSTEMS, INC.



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- On-Board Programmability
- Fast Access Time – 500 ns Typ.
- Pin Configuration Similar to the S6830 1K x 8 Bit ROM
- High Speed Programming – Less than 1 Minute for all 4096 Bits
- Programmed with R/W, CS and V_{PROG} Pins
- Completely TTL Compatible – Excluding the V_{PROG} Pin
- Ultraviolet Light Erasable – Less than 10 Minutes
- Static Operation – No Clocks Required
- Three-State Data I/O
- Standard Power Supplies +5V and –12V
- Mature P-Chan Process

FUNCTIONAL DESCRIPTION

The S6834 is a high speed, static, 512 x 8 bit, eraseable and electrically programmable read only memory designed for use in bus-organized systems. Both input and output are TTL compatable during both read and write modes. Packaged in a 24 pin hermetically sealed dual in-line package the bit pattern can be erased by exposing the chip to an ultra-violet light source through the transparent lid, after which a new pattern can be written.

TYPICAL APPLICATIONS

- ROM Program Debugging
- Code Translation
- Microprogramming
- Look-up Tables
- Random Logic Replacement
- Programmable Waveforms
- Character Generation
- Electronic Keyboards

MICROPROCESSOR AMI

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ABSOLUTE MAXIMUM RATINGS

Voltage on any pin relative to V_{SS} except the V_{PROG} pin	+0.3 to −20V
Voltage on the V_{PROG} pin relative to V_{SS}	+0.3 to −55V
Operating Temperature	0°C to +70°C
Storage Temperature (programmed)	−55°C to +85°C
Storage Temperature (unprogrammed)	−55°C to 150°C

NOTE: This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields, however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high-impedance circuit.

DC (STATIC) CHARACTERISTICS (V_{CC} = +5.0V ± 5%, V_{GG} = −12.0V ± 5% T_A = 0 − 70°C unless otherwise noted).

SYMBOL	CHARACTERISTIC	MIN	MAX	UNIT
V_{IL}	INPUT VOLTAGE LOW		0.8	V
V_{IH}	INPUT VOLTAGE HIGH	V_{CC} −2.25	V_{CC} to .3	V
V_{OL}	OUTPUT VOLTAGE LOW I_{OL} = 1.6 ma		0.4	V
V_{OH}	OUTPUT VOLTAGE HIGH I_{OH} = 40 μa	2.4		V
I_{LI}	INPUT LEAKAGE CURRENT		10	μa
I_{LO}	OUTPUT LEAKAGE CURRENT CS = 5V		20	μa
I_{GG}	V_{GG} SUPPLY CURRENT		45	ma
I_{CC}	V_{CC} SUPPLY CURRENT		50	ma
P_D	POWER DISSIPATION		750	mw

NOTE: Program input V_{PROG} may be tied to V_{CC} during the Read.

AC (DYNAMIC) CHARACTERISTICS (Loading is as shown in Figure 1 unless otherwise noted).

SYMBOL	CHARACTERISTIC	MIN	MAX (6834)	MAX (6834−1)	UNIT
T_{ACC}	ACCESS TIME		575	750	ns
T_{CO}	CHIP SELECT TO OUTPUT DELAY		300	400	ns
T_{DD}	CHIP DESELECT TO OUTPUT DELAY		250	325	ns

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FIGURE 1 — TEST CONDITIONS

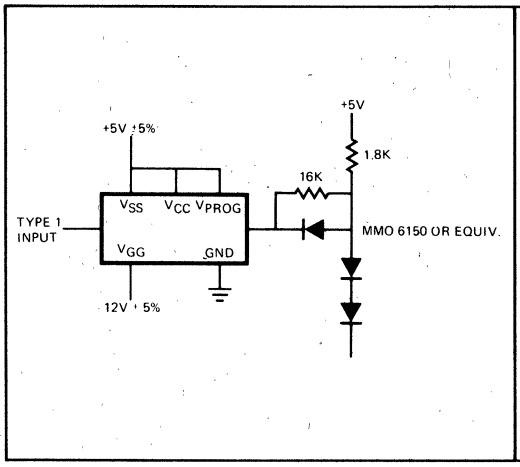
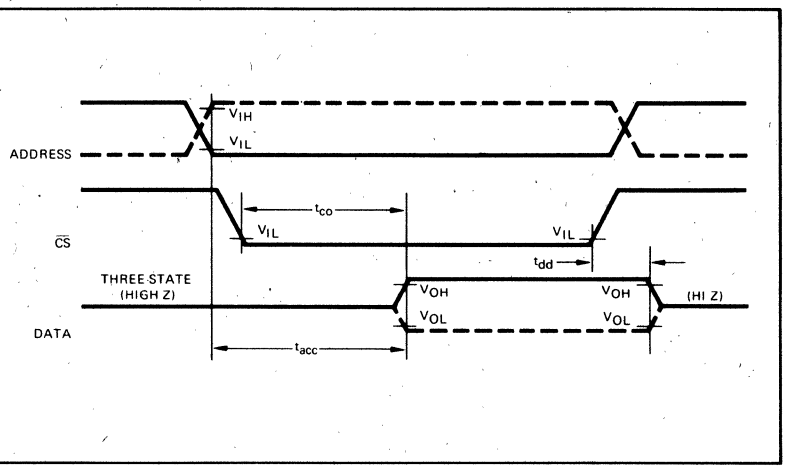


FIGURE 2 — READ CYCLE TIMING WAVEFORMS



PROGRAM CHARACTERISTICS (R/W G_{nd}, Program pulse rise and fall time (10% to 90%) are both at 1μs max).

SYMBOL	CHARACTERISTICS	MIN	MAX	UNIT
T_{AS}	ADDRESS SET UP TIME	10		μs
T_{CSS}	CHIP SELECT SET UP TIME	10		μs
T_{DS}	DATA SET UP TIME	10		μs
T_{AH}	ADDRESS HOLD TIME	10		μs
T_{CSH}	CHIP SELECT HOLD TIME	10		μs
T_{DH}	DATA HOLD TIME	10		μs
T_{PWL}	PROGRAM PULSE WIDTH LOW	3	5	ms
T_{PWH}	PROGRAM PULSE WIDTH HIGH	500		μs
V_{PROG}	PROGRAM AMPLITUDE	−55	−50	V
I_{PROG}	PROGRAM CURRENT		35	ma
T_{WS}	WRITE SET UP TIME	10		μs
T_{WH}	WRITE HOLD TIME	5		μs
T_{RS}	READ SET UP TIME	10		μs

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FIGURE 3 —PROGRAMMING CYCLE TIMING WAVEFORMS

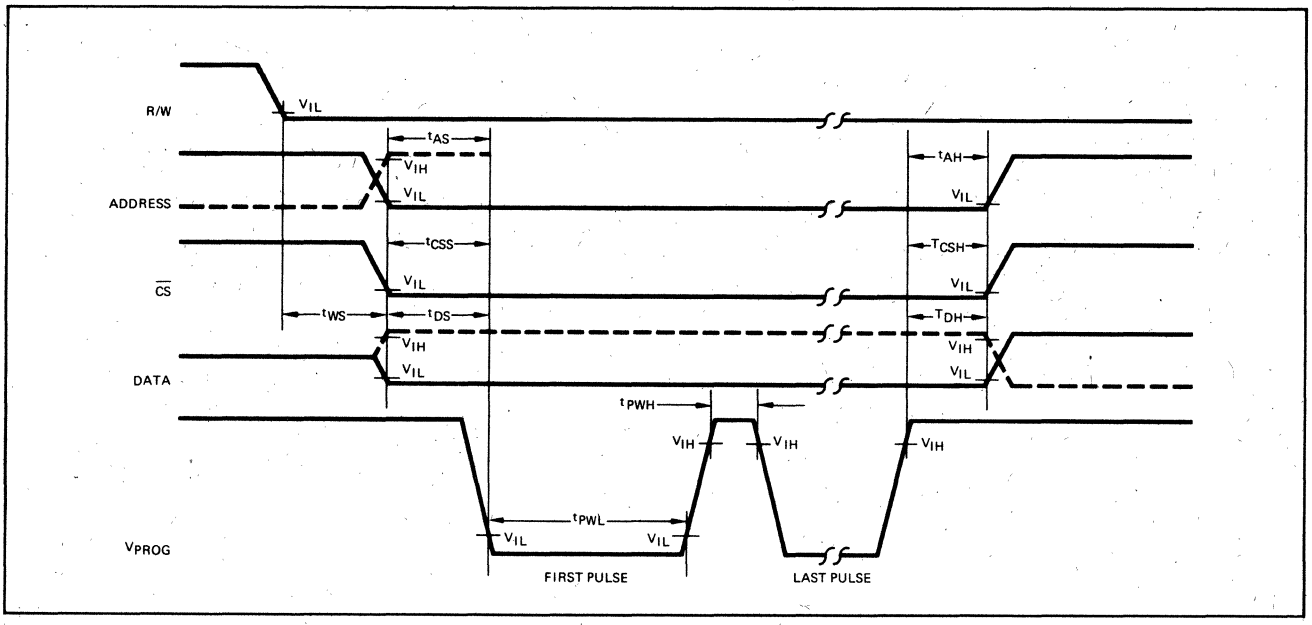
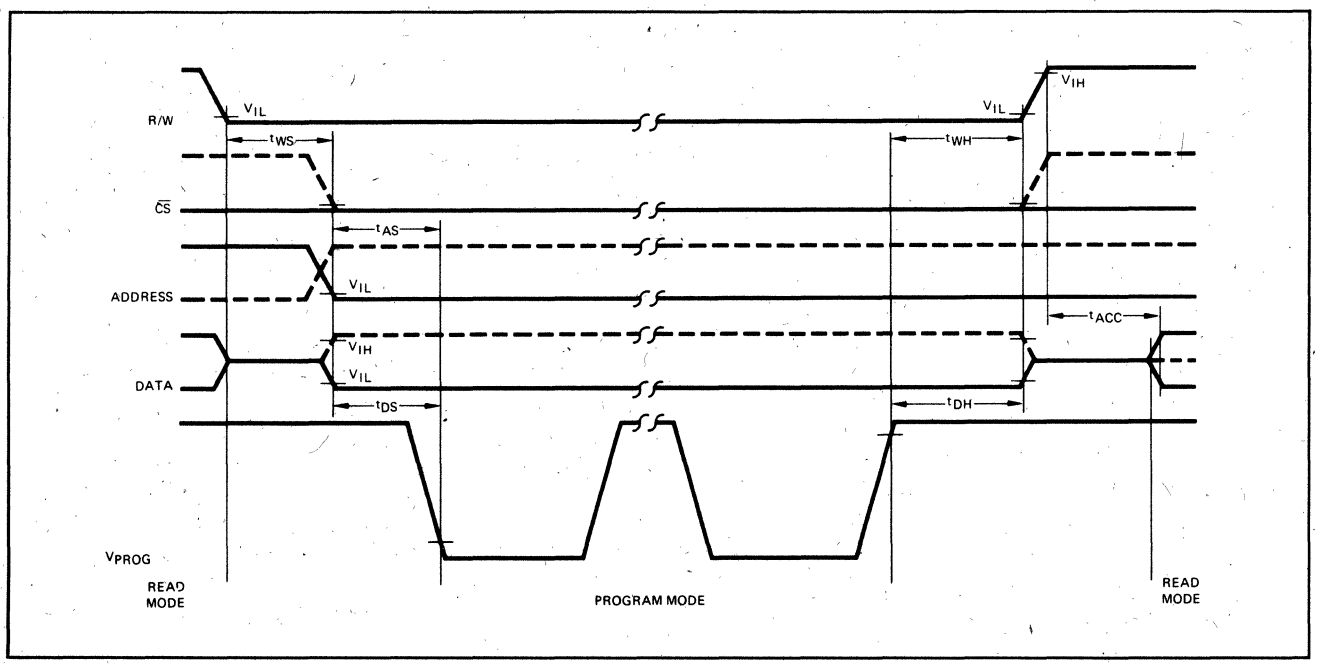


FIGURE 4 —READ/PROGRAM/READ CYCLE TIMING WAVEFORM



CONTROL FUNCTION TRUTH TABLE

CS	R/W	V_{PROG}	MODE	OUTPUTS
0	0	V_{PROG}	Write	Active Data Inputs
0	1	V_{CC}	Read	Active
1	X	X	Standby	Floating

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OPERATION

Initially, and after each erasure, all bits of the 6834 are in the logic "0" state (output 0 volts). Data is stored by selectively programming a logic "1" into the desired bit locations. The R/W input (pin 14) is used to select the desired mode of operation. When the R/W input is at logic "0" the chip is in the write enable mode of operation. The outputs (0_1 –0_8) are disabled (floating) with the corresponding pins becoming the data inputs ($0_1 \rightarrow D_{IN\ 1}$ etc.). The word address is selected in the same manner as in the read mode. Data to be programmed are presented 8 bits in parallel and after the address and data are set up a programming pulse (V_P –50 volts) is applied. V_{PROG} electrically writes the data into the memory array. Writing may be inhibited by deselecting the chip with the CS input at a logic "1" during the write cycle. This feature allows true "on board" programming in bus organized systems where the R/W and V_{PROG} inputs are common and the device to be programmed is selected by means of the chip select input as during read operations.

The amount of program energy required to insure memory retention may be defined as a function of the number of program pulses (N) times the program pulse width (t_{pw}) ($N \times t_{pw} \geqslant 60$ msec). This means if a 3 ms pulse is used, 20 program pulses are required, and if a 5 ms pulse is used 12 program pulses are required.

The read operation is accomplished by a logic "1" at the R/W input with the program input connected to V_{SS} potential. True data (data out = data in) is valid after the address is stable. The CS input will disable (float) the outputs when at a logic "1" to allow or tie capability.

Erasure is accomplished by exposing the array to a high intensity ultra-violet light source (such as, Ultra-Violet Products, Inc. Lamp Model S52 or UVS-54) for a period of 7 to 10 minutes. The clear optical lid should be approximately one inch away from the lamp tubes.

INTERFACE DESCRIPTION

Pin	Label	Function
(2)	D0	**Data Lines** – with the R/W line selected for Read (V_{IH}), the Data Lines (D0 through D7) are set to reflect the contents of the selected memory location. When the R/W line is set for Write (V_{IL}), the Data Lines are input to the addressed location of the 6834 when V_{PROG} is present. The Data Bus output drivers are three-state devices that remain in the high impedance (off) state when CS is in the V_{IH} state of when R/W is in the V_{IL} state.
(3)	D1	
(4)	D2	
(5)	D3	
(6)	D4	
(7)	D5	
(8)	D6	
(9)	D7	
(14)	R/W	**Read/Write** – When this input line is set to V_{IH}, the device is in the Read mode, a low (V_{IL}) signal puts it into the Write mode.
(15)	CS	**Chip Select** – This input line must be set to V_{IL} for a Read or Write operation to be performed. When it is High (V_{IH}) the output data bus is set to a high-impedance three-state condition and disables the Write operation.
(11)	V_{PROG}	**Program** – In the Write mode, a programming pulse (–50V dc) at this input causes the data at the Data Lines to be stored in the selected address. This pin should be tied to V_{CC} for normal Read operations.
(24)	A0	**Address Lines** – These lines select the 8 bit word in memory for Read or Write operation
(23)	A1	
(22)	A2	
(21)	A3	
(20)	A4	
(19)	A5	
(18)	A6	
(17)	A7	
(16)	A8	

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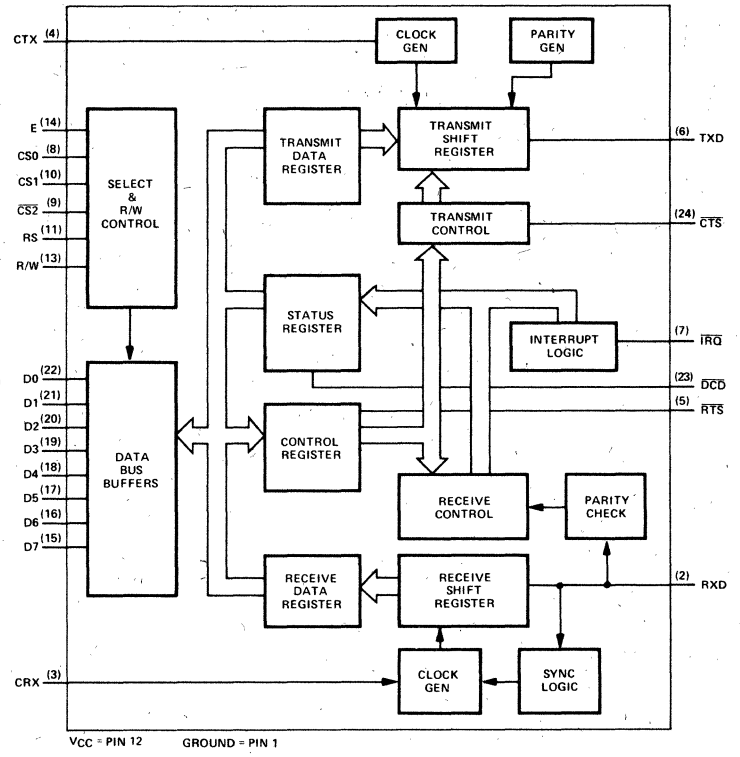
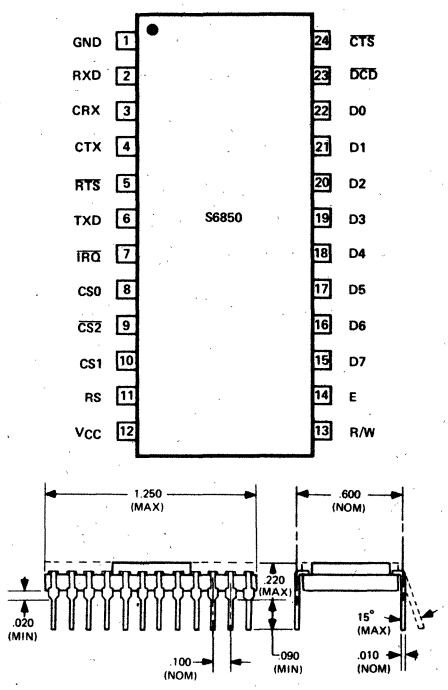
AMERICAN MICROSYSTEMS, INC.

S6850

ASYNCHRONOUS COMMUNICATION INTERFACE ADAPTER (ACIA)



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- 8 Bit Bidirectional Data Bus for Communication with MPU.
- False start bit deletion.
- Peripheral/modem control functions.
- Double buffered Receiver and Transmitter
- One or two stop bit operation.
- Eight and nine-bit transmission with optional even and odd parity.
- Parity, overrun and framing error checking.
- Programmable control register.
- Optional ÷1, ÷16, and ÷64 clock modes.
- Up to 500,000 bps transmission.

FUNCTIONAL DESCRIPTION

The S6850 Asynchronous Communications Interface Adapter (ACIA) provides the data formatting and control to interface serial asynchronous data communications to bus organized systems such as the S6800 Microprocessing Unit.

The S6850 includes select enable, read/write, interrupt and bus interface logic to allow data transfer over an eight bit bi-directional data bus. The parallel data of the bus system is serially transmitted and received by the asynchronous data interface, with proper formatting and error checking. The functional configuration of the ACIA is programmed via the data bus during system initialization. Word lengths, clock division ratios and transmit control through the Request to Send output may be programmed. For modem operation three control lines are provided. These lines allow the ACIA to interface directly with the S6860 0-600 bps digital modem.

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ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC}	−0.3 to +7.0V	Operating Temperature Range T_A	0 to +70°C
Input Voltage V_{in}	−0.3 to +7.0V	Storage Temperature Range T_{stg}	−55 to +150°C

NOTE: This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields, however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high-impedance circuit.

DC (STATIC) CHARACTERISTICS (V_{CC} = 5.0V ± 5%, T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Input High Voltage (Normal Operating Levels)	V_{IH}	+2.4	–	V_{CC}	Vdc
Input Low Voltage (Normal Operating Levels)	V_{IL}	−0.3	–	+0.4	Vdc
Input High Threshold Voltage All Inputs Except Enable	V_{IHT}	+2.0	–	–	Vdc
Input Low Threshold Voltage All Inputs Except Enable	V_{ILT}	–	–	+0.8	Vdc
Input Leakage Current (V_{in} = 0 to 5.0 Vdc) R/W, RS, CS0, CS1, $\overline{CS2}$, Enable	I_{in}	–	1.0	2.5	μAdc
Three-State (Off State) Input Current (V_{in} = 0.4 to 2.4 Vdc, V_{CC} = max) D0-D7,	I_{TSI}	–	2.0	10	μAdc
Output High Voltage (I_{Load} = −100 μAdc, Enable Pulse Width < 25 μs) All Outputs Except $\overline{IRQ}$	V_{OH}	+2.4	–	–	Vdc
Output Low Voltage (I_{Load} = 1.6 mAdc) Enable Pulse Width < 25 μs	V_{OL}	–	–	+0.4	Vdc
Output Leakage Current (Off State) $\overline{IRQ}$	I_{LOH}	–	1.0	10	μAdc
Power Dissipation	P_D	–	300	525	mW
Input Capacitance (V_{in} = 0, T_A = 25°C, f = 1.0 MHz)	C_{in}				pF
D0-D7		–	–	10	
R/W, RS, CS0, CS1, $\overline{CS2}$, RXD, CTX, CRX, $\overline{CTS}$, $\overline{DCD}$		–	–		
Enable		–	–	10	
Output Capacitance (V_{in} = 0, T_A = 25°C, f = 1.0 MHz)	C_{out}	–	–	10	pF

AC (DYNAMIC) CHARACTERISTICS

Loading = 130 pF and one TTL load for D0-D7 = 20pF and 1 TTL load for $\overline{RTS}$ and TXD = 100pF and 3KΩ to V_{CC} for $\overline{IRQ}$.

READ TIMING CHARACTERISTICS (Figure 1)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Setup Time, Address valid to Enable positive transition	T_{AEW}	180	–	–	ns
Setup Time, Enable positive transition to Data valid on bus	T_{EDR}	–	–	395	ns
Data Bus Hold Time	T_{HR}	10	–	–	ns
Rise and Fall Time for Enable input	t_{rE}, t_{fE}	–	–	25	μs

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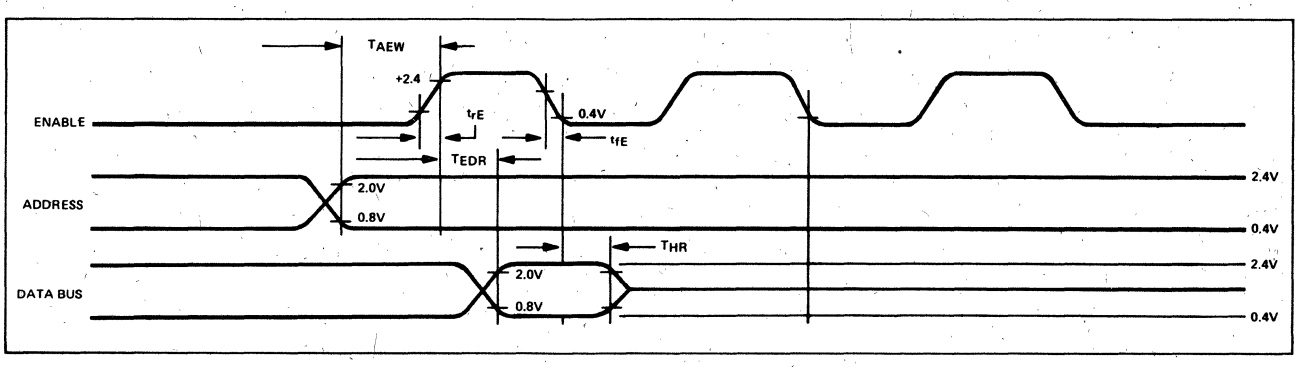
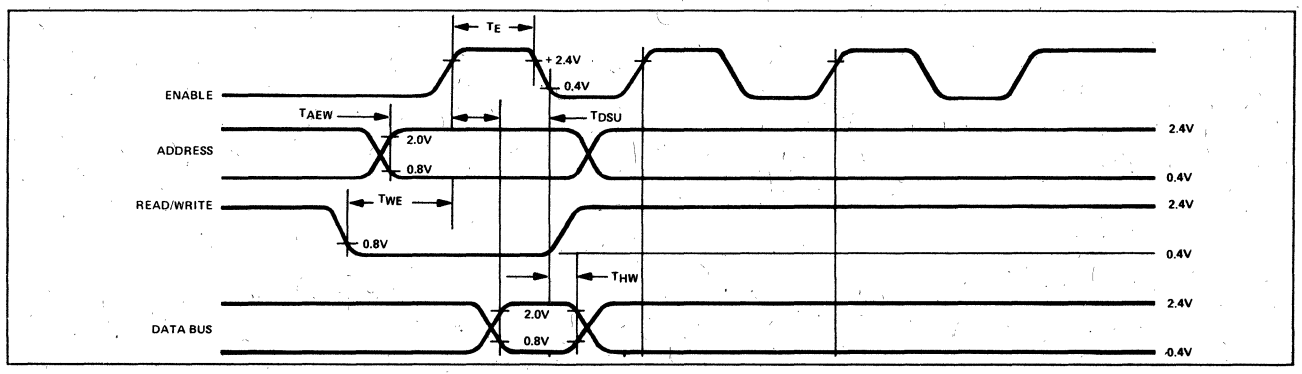
FIGURE 1 – READ TIMING CHARACTERISTICS



WRITE TIMING CHARACTERISTICS (Figure 2)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Enable Pulse Width	T_E	0.470	–	25	μs
Setup Time, Address valid to Enable positive transition	T_{AEW}	180	–	–	ns
Setup Time, Data valid to Enable netative transition	T_{DSU}	300	–	–	ns
Setup time, Read/Write negative transition to Enable positive transition	T_{WE}	130	–	–	ns
Data Bus Hold Time	T_{HW}	10	–	–	ns

FIGURE 2 – WRITE TIMING CHARACTERISTICS



TRANSMIT/RECEIVE CHARACTERISTICS (Figure 3)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
Clock Frequency ÷ 1 mode ÷ 16 mode ÷ 64 mode	f_C			 500 800 800	 KHz KHz KHz
Clock Pulse Width, Low State	PW_{CL}	600			nsec
Clock Pulse Width, High State	PW_{CH}	600			nsec
Delay Time, Transmit Clock to Data Out	T_{TDD}			1.0	μsec
Set up Time, Receive Data	T_{RDSU}	500			nsec
Hold Time, Receive Data	T_{RDH}	500			nsec
Delay Time, Enable to $\overline{IRQ}$ Reset	T_{IRQR}			1.2	μsec
Delay Time, Enable to $\overline{RTS}$	T_{RTS}			1.0	μsec

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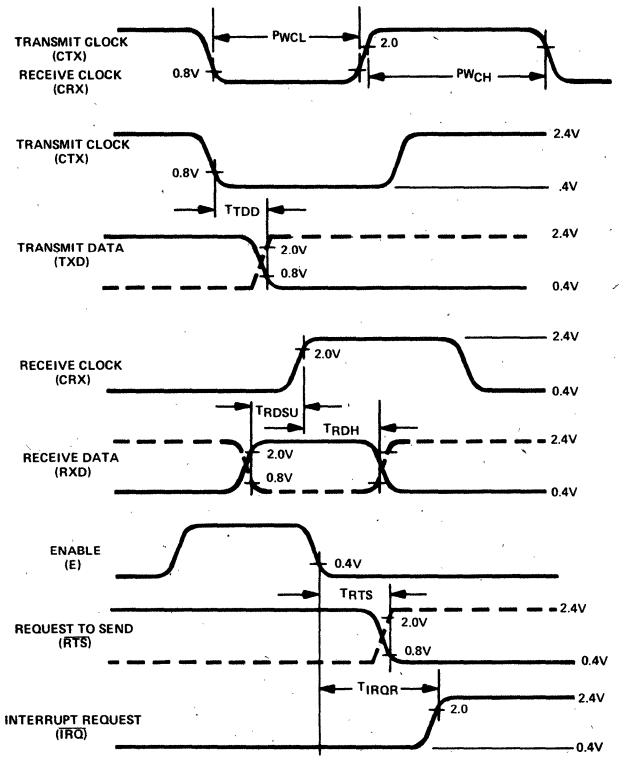
FIGURE 3 – TRANSMIT/RECEIVE TIMING



MPU/ACIA INTERFACE

Pin	Label	Function
(22)	D0	**ACIA BI-DIRECTIONAL DATA LINES**–The bi-directional data lines (D0-D7) allow for data transfer between the ACIA and the MPU. The data bus output drivers are three-state devices that remain in the high-impedance (off) state except when the MPU performs an ACIA read operation. The Read/Write line is in the read (high) state when the ACIA is selected for a read operation.
(21)	D1	
(20)	D2	
(19)	D3	
(18)	D4	
(17)	D5	
(16)	D6	
(15)	D7	
(14)	E	**ACIA ENABLE SIGNAL**–The Enable signal (E) is a high impedance TTL compatible input that enables the bus input/output data buffers and clocks data to and from the ACIA. This signal will normally be a derivative of the S6800 $\phi 2$ clock.
(13)	R/W	**READ/WRITE CONTROL SIGNAL**–The Read/Write line is a high impedance input that is TTL compatible and is used to control the direction of data flow through the ACIA's input/output data bus interface. When Read/Write is high (MPU Read cycle), the ACIA output driver is turned on and a selected register is read. When it is low, the ACIA output driver is turned off and the MPU writes into a selected register. Thus, the Read/Write signal is used to select the Read Only or Write Only registers within the ACIA.
(8)	CS0	**CHIP SELECT SIGNALS**–These three high impedance TTL compatible input lines are used to address an ACIA. A particular ACIA is selected when CS0 and CS1 are high and $\overline{CS2}$ is low. Transfers of data to and from ACIA are then performed under the control of Enable, Read/Write, and Register Select.
(10)	CS1	
(9)	$\overline{CS2}$	

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MPU/ACIA INTERFACE (CONT'D)

Pin	Label	FUNCTION
(11)	RS	**REGISTER SELECT SIGNAL**–The Register Select line is a high impedance input that is TTL compatible and is used to select the Transmit/Receive Data or Control/Status registers in the ACIA. The Read/Write signal line is used in conjunction with Register Select to select the Read Only or Write Only register in each register pair.
(7)	$\overline{IRQ}$	**INTERRUPT REQUEST SIGNAL**–Interrupt request is a TTL compatible, open drain active low output that is used to interrupt the MPU. The Interrupt Request remains low as long as the cause of the interrupt is present and the appropriate interrupt enable within the ACIA is set.

ACIA/MODEM OR PERIPHERAL INTERFACE

Pin	Label	FUNCTION
(4)	CTX	**TRANSMIT CLOCK**–The Transmit Clock is a high impedance TTL compatible input used for the clocking of transmitted data. The transmitter initiates data on the negative transition of the clock. Clock frequency of 1, 16, or 64 times the data rate may be selected.
(3)	CRX	**RECEIVE CLOCK**–The Receive Clock is a high impedance TTL compatible input used for synchronization of received data. (In the ÷ 1 mode, the clock and data must be synchronized externally.) The receiver strobes the data on the positive transition of the clock. Clock frequency of 1, 16, or 64 times the data rate may be selected.
(2)	RXD	**RECEIVED DATA**–The Received Data line is a high impedance TTL compatible input through which data is received in a serial NRZ(Non Return to Zero) format. Synchronization with a clock for detection of data is accomplished internally when clock rates of 16 or 64 times the bit rate are used. Data rates are in the range of 0 to 500 Kbps when external synchronization is utilized.
(6)	TXD	**TRANSMIT DATA**–The Transmit Data output line transfers serial NRZ data to a modem or other peripheral device. Data rates are in the range of 0 to 500Kbps when external synchronization is utilized.
(24)	$\overline{CTS}$	**CLEAR-TO-SEND**–This high impedance TTL compatible input provides automatic control of the transmitting end of a communications link via the modem's "clear-to-send" active low output by inhibiting the Transmitter Data Register Empty status bit (TDRE).
(5)	$\overline{RTS}$	**REQUEST-TO-SEND**–The Request-to-Send output enables the MPU to control a peripheral or modem via the data bus. The active state is low. The Request-to-Send output is controlled by the contents of the ACIA control register.
(23)	$\overline{DCD}$	**DATA CARRIER DETECTED**–This high impedance TTL compatible input provides automatic control of the receiving end of a communications link by means of the modem "Data-Carrier-Detect" or "Received-Line-Signal Detect" output. The $\overline{DCD}$ input inhibits and initializes the receiver section of the ACIA when high. A low to high transition of the Data Carrier Detect initiates an interrupt to the MPU to indicate the occurrence of a loss of carrier when the Receiver Interrupt Enable (RIE) is set.
(12)	V_{CC}	**+5 volts ± 5%**
(1)	GND	**GROUND**

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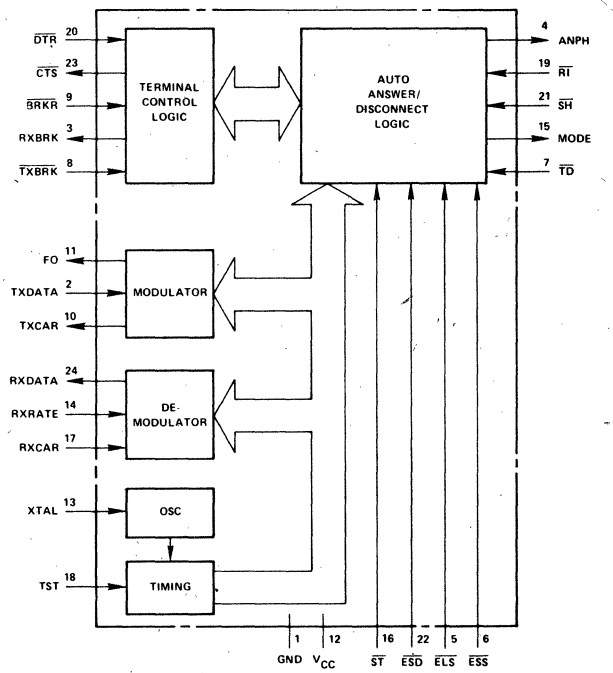
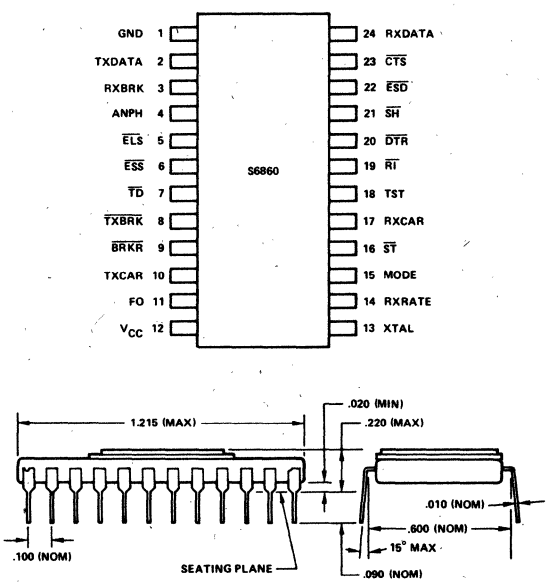
S6860

0-600 BPS
DIGITAL MODEM

AMERICAN MICROSYSTEMS, INC.



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- Full or half duplex operation
- Originate and answer mode
- Auto answer and disconnect
- Modem self test
- TTL compatible terminal interfaces
- Crystal/External reference control
- Compatible functions for 100 series data sets and 1001 A/B data couplers

FUNCTIONAL DESCRIPTION

The S6860 is a 0-600 bps Digital Modem circuit designed to be integrated into a wide range of equipment utilizing serial data communications.

The modem provides the necessary modulation, demodulation and supervisory control functions to implement a serial data communications link, over a voice grade channel, utilizing frequency shift keying (FSK) a bit rates up to 600 bps. The S6860 can be implemented into a wide range of data handling systems, including stand alone modems, data storage devices, remote data communication terminals and I/O interfaces for minicomputers.

N-channel silicon gate technology permits the S6860 to operate using a single voltage supply and be fully TTL compatible.

The modem is compatible with the S6800 microcomputer family, interfacing directly with the Asynchronous Communications Interface Adapter (ACIA) to provide low-speed data communications capability.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_{CC}	- 0.3 to +7.0V	Operating Temperature Range T_A	0 to 70°C
Input Voltage V_{IN}	- 0.3 to +7.0V	Storage Temperature Range T_{STG}	- 50 to 150°C

NOTE: This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields, however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high-impedance circuit.

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DC (STATIC) CHARACTERISTICS

(V_{CC} = 5.0V ± 5%, T_A = 25°C unless otherwise noted.)

SYMBOL	CHARACTERISTIC	MIN	TYP	MAX	UNIT
V_{IH}	Input High Voltage, All inputs Except Crystal	2.0	–	V_{CC}	Vdc
V_{IL}	Input Low Voltage, All inputs Except Crystal	-0.3	–	0.8	Vdc
V_{IN}	Crystal Input Voltage (Crystal Input Driven from an External Reference, Input Coupling Capacitor = 200 pF, Duty Cycle = 50 ± 5%)	1.5	–	2.0	V_{p-p}
I_{IN}	Input Current				mAdc
	(V_{IN} = GND) All Inputs Except RXCAR,TXDATA, $\overline{TD}$, TST, $\overline{RI}$, $\overline{SH}$	–	–	-0.2	
	$\overline{RI}$, $\overline{SH}$ Inputs	–	–	-1.6	
I_{IL}	Input Leakage Current (V_{IN} = 0 to 5.0 Vdc)	–	–	1.	μAdc
V_{OH1}	Output High Voltage, All Outputs Except ANPH and TXCAR (I_{OH1} = -0.04 mAdc, Load A)	2.4	–	V_{CC}	Vdc
V_{OL1}	Output Low Voltage, All Outputs Except ANPH and TXCAR (I_{OL1} = 1.6 mAdc, Load A)	-0.3	–	0.4	Vdc
I_{OH2}	Output High Current, ANPH (V_{OH2} = 0.8 Vdc, Load B)	0.3	–	–	mAdc
V_{OL2}	Output Low Voltage, ANPH (I_{OL2}) = 0, Load B)	-0.3	–	0.3	Vdc
C_{IN}	Input Capacitance (f = 0.1 MHz)	–	5.	–	pF
C_{OUT}	Output Capacitance (f = 0.1 MHz)	–	10	–	pF
V_{CO}	Transmit Carrier Output Voltage (Load C)	0.20	0.35	0.50	V(RMS)
V_{2H}	Transmit Carrier Output 2nd Harmonic (Load C)	-25	-32	–	dB
I_{DD}	V_{CC} Supply Current (All Inputs at GND & All Outputs Open)	–	30	65	mAdc

AC (DYNAMIC) CHARACTERISTICS

(Loading is as shown in Figure 1 unless otherwise noted.)

SYMBOL	CHARACTERISTIC	MIN	TYP	MAX	UNIT
t_r	Input Transition Times, All Inputs Except Crystal	–	–	1.*	μs
t_f	(Operating in the Crystal Input Mode; from 10% to 90% Points)	–	–	1.*	
t_r	Input Transition Times, Crystal Input	–	–	30.	ns
t_f	(Operating in External Input Reference Mode)	–	–	30	
t_r	Output Transition Times, All Outputs Except TXCAR	–	–	5.	μs
t_f	(From 10% to 90% Points)	–	–	5.	

*Maximum Input Transition Times are ≤0.1 x Pulse Width or the specified maximum of 1.0 μs, whichever is smaller.

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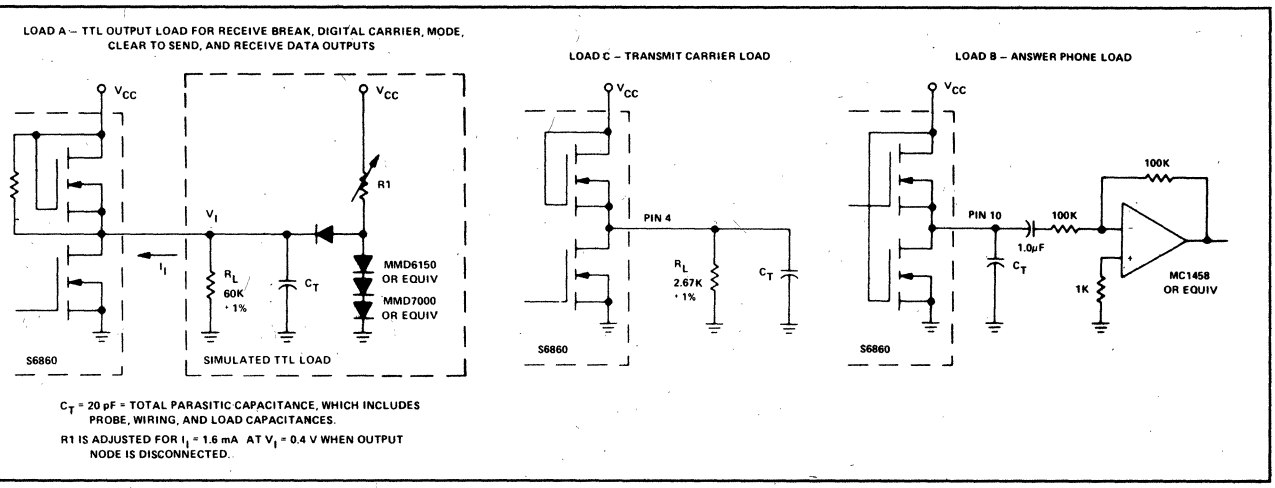
FIGURE 1 TEST LOADING



MODEM/TERMINAL INTERFACE

PIN	LABEL	FUNCTION
(2)	TXDATA	**Transmit Data** – Serial data transferred to the modem via the ACIA for transmitting to the receiving terminal.
(8)	$\overline{\text{TXBRK}}$	**Transmit Break** – Used to signal the remote modem to stop transmitting data. A Transmit Break (low) greater than 34 ms forces the modem to send a continuous space signal for 233 ms. Transmit Break must be initiated only after $\overline{\text{CTS}}$ has been established. This is a negative edge sense input. Prior to initiating $\overline{\text{TXBRK}}$ this input must be held high for a minimum of 34 ms.
(24)	RXDATA	**Receive Data** – The data resulting from demodulating the Receive Carrier signal. A high level is a mark.
(3)	RXBRK	**Receive Break** – Upon receipt of a continuous 150 ms space, the modem automatically clamps the Receive Break output high. This output is also clamped high until Clear-to-Send is established.
(9)	$\overline{\text{BRKR}}$	**Break Release** – The Receive Break output (clamp high condition) can be removed by holding the Break Release signal low for at least 20 μs after receiving a minimum 150 ms space signal.
(20)	$\overline{\text{DTR}}$	**Data Terminal Ready** – Enables the modem function when low. When $\overline{\text{DTR}}$ is held high for 34 ms minimum, a disconnect is initiated and will occur 3 sec. later.
(23)	$\overline{\text{CTS}}$	**Clear-to-Send** – A low on the $\overline{\text{CTS}}$ output indicates the Transmit Data input has been unclamped from a steady Mark, thus allowing data transmission.
(16)	$\overline{\text{ST}}$	**Self Test** – With this input at a low level, the demodulator is switched to the modulator frequency and demodulates the transmitted FSK signal. Channel establishment, which occurred during the initial handshake, is not lost during self test. The Mode Control output changes state during Self Test, permitting the receive filters to pass the local Transmit Carrier.
(18)	TST	**Test Clock** – A high input signal decreases the modem test time. This input **must be low** for normal operation.
(11)	FO	**Frequency Output** – A test signal is output to decrease modem test time. The signal is a square wave at the transmit frequency.

$\overline{\text{ST}}$	$\overline{\text{SH}}$	$\overline{\text{RI}}$	MODE
H	L	H	H
H	H	L	L
L	L	H	L
L	H	L	H

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EXTERNAL MODEM INTERFACE

PIN	LABEL	FUNCTION
(12)	V_{CC}	+ 5 Volts ± 5%
(1)	GND	**Ground**
(22)	$\overline{ESD}$	**Enable Space Disconnect** – When $\overline{ESD}$ is strapped low and $\overline{DTR}$ is pulsed to initiate a disconnect, the modem transmits a space for either 3 s or until a loss of threshold is detected, whichever occurs first. If $\overline{ESD}$ is strapped high, data instead of a space is transmitted. A disconnect occurs at the end of 3 s.
(5)	$\overline{ELS}$	**Enable Long Space Disconnect** – A strapping option which, when low, will automatically hang up the phone upon receipt of a continuous space for 1.5 s.
(6)	$\overline{ESS}$	**Enable Short Space Disconnect** – A strapping option which, when low, will automatically hang up the phone upon receipt of a continuous space for 0.3 s. **$\overline{ESS}$ and $\overline{ELS}$ must not be simultaneously strapped low.**
(13)	XTAL	**Crystal** – A 1.0 MHz crystal is required to use the on-chip oscillator. A 1.0 MHz square wave can also be applied to this pin to satisfy the clock requirements. Crystal parameteres are as follows:

Mode:	Parallel
Frequency:	1.0 MHz ± 0.1%
Series Resistance:	750 ohms max
Shunt Capacitance:	7.0 pF max
Temperature:	0 - 70°C
Test Level:	1.0 mW
Load Capacitance:	13 pF

When using the 1.0 MHz crystal, external parasitic capacitance, including crystal shunt capacitance, must be ≤ 9 pF at the crystal input.

(14)	RXRATE	**Receive Data Rate** – The demodulator has been optimized for signal-to-noise performance at 300 bps and 600 bps. The Receive Data Rate input must be low for 0-600 bps and should be high for 0-300 bps.

MODEM/DATA COUPLER INTERFACE

PIN	LABEL	FUNCTION
(15)	MODE	**Mode** – Indicates the Originate (high) or Answer (low) status of the modem. This output changes when a Self Test ($\overline{ST}$) signal is applied.
(19)	$\overline{RI}$	**Ring Indicator** – The modem function will recognize the receipt of a call from the CBT if at least 20 cycles of the 20 - 47 Hz ringing signal (low level $\geq$ 50% of the duty cycle) are present. The CBS $\overline{RI}$ signal must be level-converted to TTL according to the EIA RS-232 specification before interfacing it with the modem function. The receipt of a call from the CBS is recognized if the $\overline{RI}$ signal is present for at least 51 ms. This input is held high except during ringing. A $\overline{RI}$ signal automatically places the modem function in the Answer Mode.
(21)	$\overline{SH}$	**Switch Hook** – Interfaces directly with the CBT type Data Coupler and via the EIA RS-232 level conversion for the CBS type. An $\overline{SH}$ signal automatically places the modem function in the Originate Mode. $\overline{SH}$ is low during origination of a call. The modem will automatically hang up 17 s after releasing $\overline{SH}$ if the handshaking routine has not been accomplished.

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MODEM/DATA COUPLER INTERFACE (Continued)

PIN	LABEL	FUNCTION
(4)	ANPH	**Answer Phone** – Upon receipt of $\overline{\text{Ring Indicator}}$ or $\overline{\text{Switch Hook}}$ signal and $\overline{\text{Data Terminal Ready}}$, the Answer Phone output goes high ($[\overline{SH} + \overline{RI}] \bullet \overline{DTR}$). This signal drives the base of a transistor which activates the Off Hook and Data Transmission control lines in the data coupler. Upon call completion, the Answer Phone signal returns to a low level.
(7)	$\overline{TD}$	**Threshold Detect** – This input is derived from an external threshold detector. If the signal level is sufficient, the $\overline{TD}$ input must be low for 20 μs at least once every 32 ms to maintain normal operation. An insufficient signal level indicates the absence of the Receive Carrier; an absence for less than 32 ms will not cause channel establishment to be lost; however, data during this interval will be invalid. If the signal is present and the level is acceptable at all times, then the threshold input can be low permanently. Loss of threshold for 51 ms or longer results in a loss of Cler-to-Send. The Transmit Carrier of the originate modem is clamped off and a constant Mark is transmitted from the answer modem.
(17)	RXCAR	**Receive Carrier** – The FSK input to the demodulators. The local Transmit Carrier must be balanced or filtered out prior to this input, leaving only the Receive Carrier in the signal. The Receive Carrier must also be hard limited. Any half cycle period greater than or equal to 429 ± 1.0 μs for the low band or 235 ± 1.0 μs for the high band is detected as a space.
(10)	TXCAR	**Transmit Carrier** – A digitally synthesized sine wave derived from a 1.0 MHz crystal reference (see Figure 2). Frequency characteristics are given in the following table.

MODE	DATA	FREQUENCY	TOLERANCE*
Originate	Mark	1270 Hz	- 0.15 Hz
Originate	Space	1070 Hz	- 0.09 Hz
Answer	Mark	2225 Hz	- 0.31 Hz
Answer	Space	2025 Hz	- 0.71 Hz

*The reference frequency tolerance is not included.

The proper output frequency is transmitted within 3.0 μs following a data bit change with no more than 2.0 μs phase discontinuity. The typical output level is 0.35 V (RMS) into a 100K-ohm load impedance.

The second harmonic is typically 32 dB below the fundamental (see Figure 3).

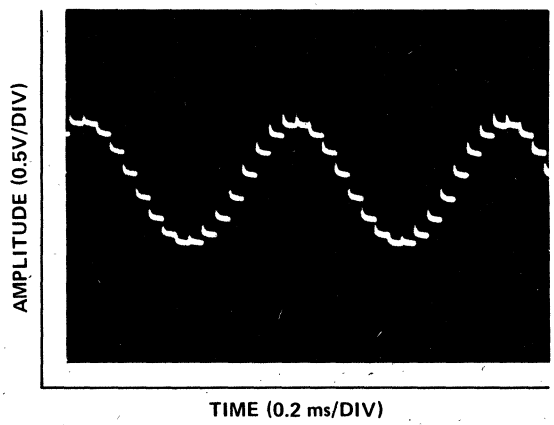

FIGURE 2 TRANSMIT CARRIER SINE WAVE

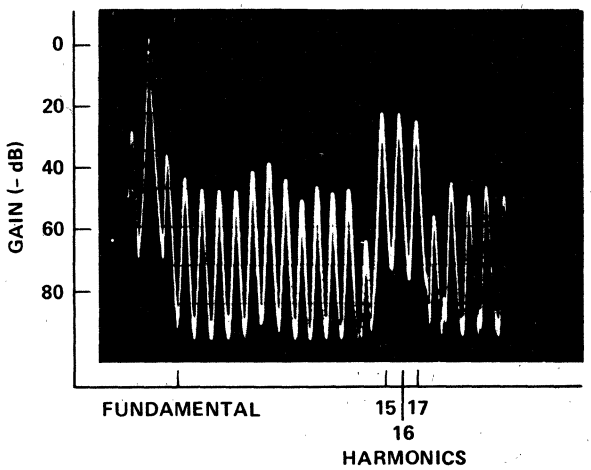

FIGURE 3 TRANSMIT CARRIER FREQUENCY SPECTRUM

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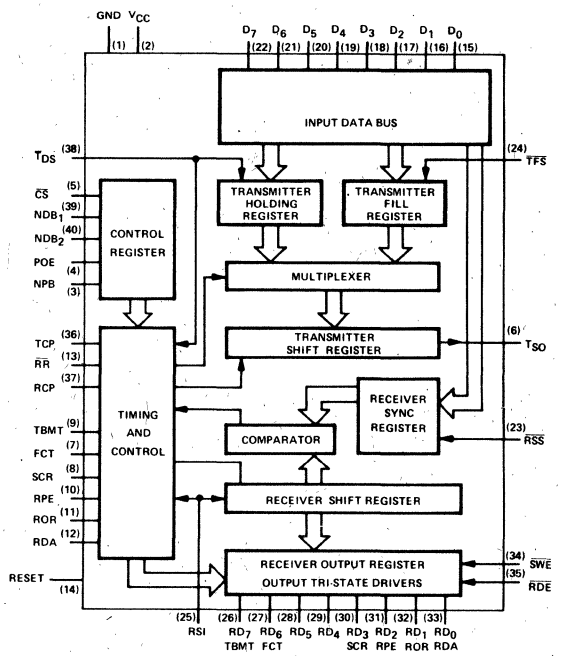
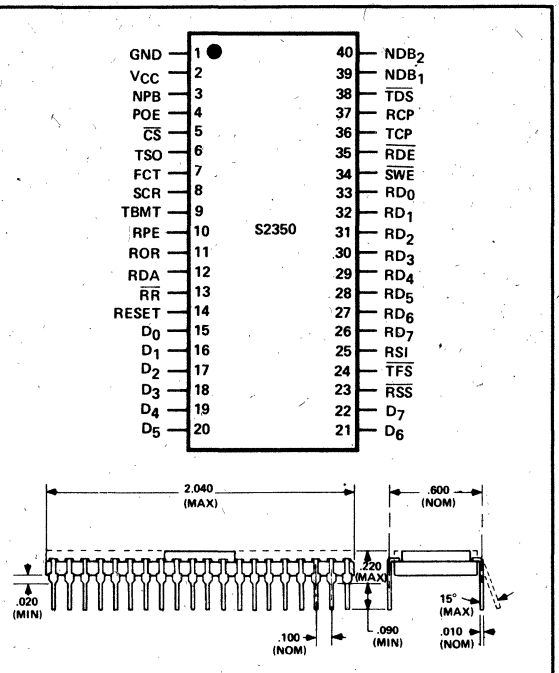
S2350

UNIVERSAL SYNCHRONOUS
RECEIVER/TRANSMITTER (USRT)

AMERICAN MICROSYSTEMS, INC.



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- 500 KHz Data Rates
- Internal Sync Detection
- Fill Character Register
- Double Buffered Input/Output
- Bus Oriented Outputs
- 5–8 Bit Characters
- Odd/Even or No Parity
- Error Status Flags
- Single Power Supply (+5v)
- Input/Output TTL Compatible

FUNCTIONAL DESCRIPTION

The S2350 Universal Synchronous Receiver Transmitter (USRT) is a single chip MOS/LSI device that totally replaces the serial to parallel and parallel to serial conversion logic required to interface a word parallel controller or data terminal to a bit-serial, synchronous communication network.

The USRT consists of separate receiver and transmitter sections with independent clocks, data lines and status. Common with the transmitter and receiver are word length and parity mode. Data is transmitted and received in a NRZ format at a rate equal to the respective input clock frequency.

Data messages are transmitted as a contiguous character stream, bit synchronous with respect to a clock and character synchronous with respect to framing or "sync" characters initializing each message. The USRT receiver compares the contents of the internal Receiver Sync Register with the incoming data stream in a bit transparent mode. When a compare is made, the receiver becomes character synchronous formatting a 5, 6, 7, or 8 bit character for output each character time. The receiver has an output buffer register allowing a full character time to transfer the data out. The receiver status outputs indicate received data available (RDA), receiver overrun (ROR), receive parity error (RPE) and sync character received (SCR). Status bits are available on individual output lines and can also be multiplexed onto the output data lines for bus organized systems. The data lines have tri-state outputs.

The USRT transmitter outputs 5, 6, 7, or 8 bit characters with correct parity at the transmitter serial output (TSO). The transmitter is buffered to allow a full character time to respond to a transmitter buffer empty (TBMT) request for data. Data is transmitted in a NRZ format changing on the positive transition of the transmitter clock (TCP). The character in the transmitter fill register is inserted into the data message if a data character is not loaded into the transmitter after a TBMT request.

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TYPICAL APPLICATIONS

- Computer Peripherals
- Communication Concentrators
- Integrated Modems
- High Speed Terminals
- Time Division Multiplexing
- Industrial Data Transmission

ABSOLUTE MAXIMUM RATINGS

Ambient temperature under bias	0°C to + 70°C
Storage temperature	–65°C to +150°C
Positive voltage on any pin with respect to GROUND	+7 volt
Negative voltage on any pin with respect to GROUND	–0.5 volt
Power dissipation	0.75 watt

DC (STATIC) CHARACTERISTICS*

V_{CC} = +5V ±5V ±5%, T_A = 25°C unless otherwise noted.

Symbol	Parameter	Min.	Max.	Unit	Condition
V_{IH}	Input High Voltage	2.0	V_{CC}	Volt	
V_{IL}	Input Low Voltage	- 0.5	+0.8	Volt	
I_{IL}	Input Leakage Current		10	μa	V_{IN} = OTO V_{CC} Volts
V_{OH}	Output High Voltage	2.4		Volts	I_{OH} = –100μa
V_{OL}	Output Low Voltage		+0.4	Volts	I_{OL} = 1.6ma
C_{IN}	Input Capacitance		10	pf	V_{IN} = 0 Volt, f = 1.0 MHZ
C_{OUT}	Output Capacitance		12	pf	V_{IN} = 0 Volt, f = 1.0 MHZ
I_{CC}	V_{CC} Supply Current		100	ma	No Load

*Electrical characteristics included in this advanced product description are objective specifications and may be subject to change.

AC (DYNAMIC) CHARACTERISTICS

V_{CC} = +5V ±5%, T_A = 25°C unless otherwise noted.

Symbol	Parameter	Min.	Max.	Unit	Condition
TCP, RCP	Clock Frequency	DC	500	KHz	

Input Pulse Widths

P_{TCP}	Transmit Clock	900		nsec	C_L = 20pf
P_{RCP}	Receive Clock	900		nsec	1TTL Load
P_{RST}	Reset	500		nsec	
$P_{\overline{TDS}}$	Transmit Data Strobe	200		nsec	
$P_{\overline{TFS}}$	Transmit Fill Strobe	200		nsec	
$P_{\overline{RSS}}$	Receive Sync Strobe	200		nsec	
$P_{\overline{CS}}$	Control Strobe	200		nsec	
$P_{\overline{RDE}}$	Receive Data Enable	400		nsec	Note 1
$P_{\overline{SWE}}$	Status Word Enable	400		nsec	Note 1
$P_{\overline{RR}}$	Receiver Restart	500		nsec	

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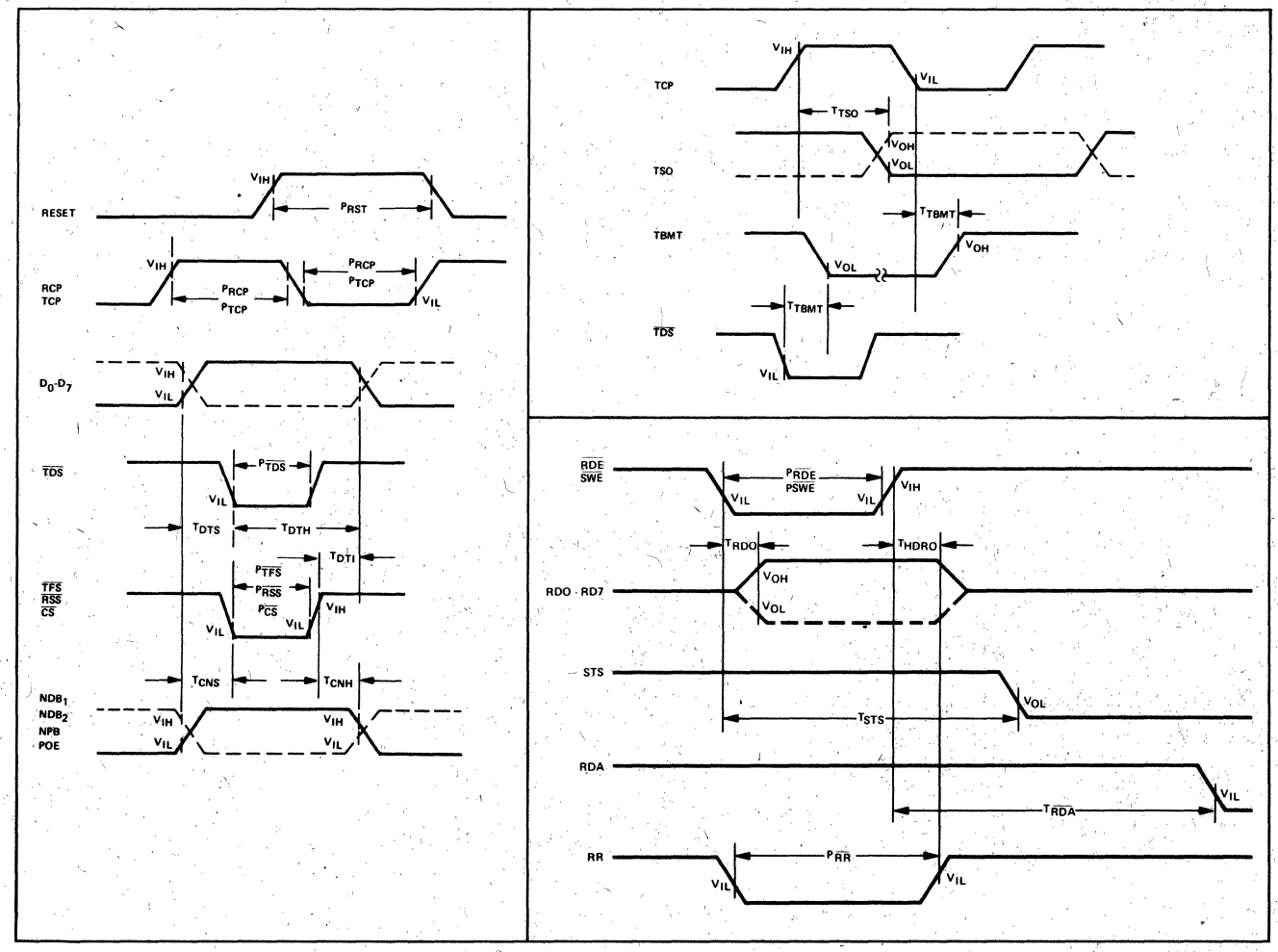
AC (DYNAMIC) CHARACTERISTICS (CONT'D)
SWITCHING CHARACTERISTICS

T_{TSO}	Delay, TCP Clock to Serial Data Out		700	nsec	
T_{TBMT}	Delay, TCP Clock to TBMT Output		1.4	μsec	
T_{TBMT}	Delay, $\overline{TDS}$ to TBMT		700	nsec	
T_{STS}	Delay, $\overline{SWE}$ to Status Reset		700	nsec	
T_{RDO}	Delay, $\overline{SWE}$, $\overline{RDE}$ to Data Outputs		400	nsec	1TTL Load
T_{HRDO}	Hold Time $\overline{SWE}$, $\overline{RDE}$ to Off State		400	nsec	C_L = 130 pf
T_{DTS}	Data Set Up Time $\overline{TDS}$, $\overline{TFS}$, $\overline{RSS}$, $\overline{CS}$	0		nsec	
T_{DTH}	Data Hold Time $\overline{TDS}$	700		nsec	
T_{DTI}	Data Hold Time $\overline{TFS}$, $\overline{RSS}$	200		nsec	
T_{CNS}	Control Set Up Time NDB1, NDB2, NPB, POE	0		nsec	
T_{CNH}	Control Hold Time NDB1, NDB2, NPB, POE	200		nsec	
T_{RDA}	Delay $\overline{RDE}$ to $\overline{RDA}$ Output	700		nsec	

NOTE 1: Required to reset status and flags.

TIMING WAVEFORMS



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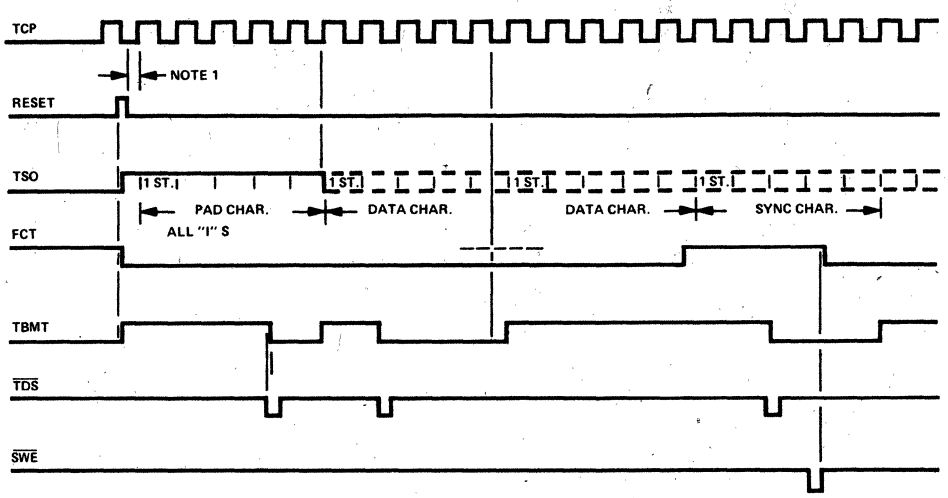
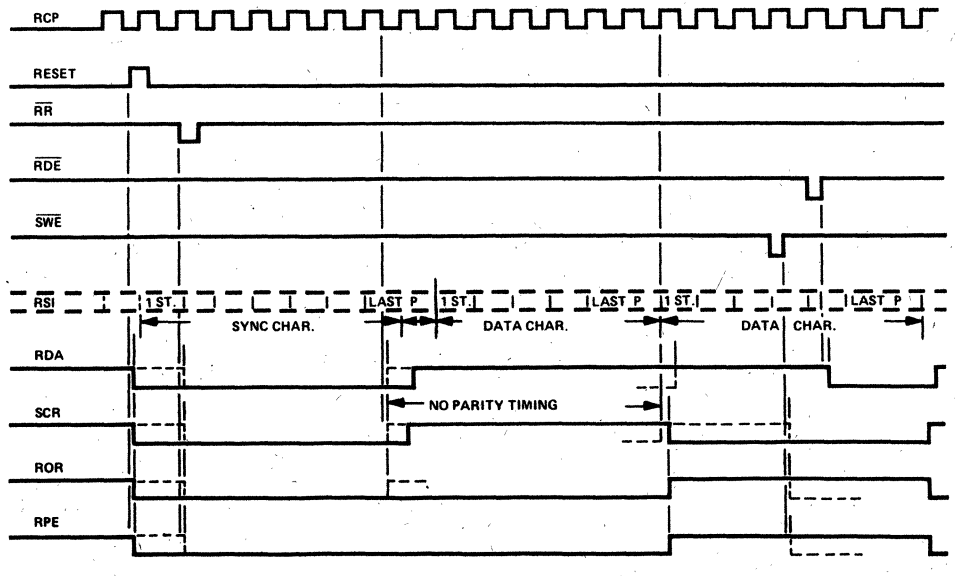
TRANSMITTER TIMING DIAGRAM



NOTE 1 DATA TRANSMISSION WILL START ON THE FIRST LOW TO HIGH TRANSITION OF TCP AFTER RESET IS LOW. THE INITIAL RESET PULSE SHOULD NOT OCCUR UNTIL 100 MICROSECONDS AFTER POWER IS APPLIED.

RECEIVER TIMING DIAGRAM



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MPU/ACIA INTERFACE (CONT'D)

Pin	Label	Function
(1)	GND	Ground
(2)	V_{CC}	+5 VOLTS ±5%
(14)	RESET	MASTER RESET A V_{IH} initializes both the receiver and transmitter. The Transmitter Shift Register is set to output a character of all logic 1's. FCT is reset to V_{OL} and TBMT set to V_{OH} indicating the Transmitter Holding Register is empty. The receiver status is initialized to a V_{OL} on RPE, SCR, and RDA. The sync character detect logic is inhibited until a RR pulse is received.
(15) (16) (17) (18) (19) (20) (21) (22)	D0 D1 D2 D3 D4 D5 D6 D7	DATA INPUTS Data on the eight data lines are loaded into the Transmitter Holding Register by $\overline{TDS}$, the Transmitter Fill Register by $\overline{TFS}$, and the Receiver Sync Register by $\overline{RSS}$. The character is right justified with the LSB at D0. For word lengths less than 8 bits, the unused inputs are ignored. Data transmission is LSB first.
(38)	TDS	TRANSMIT DATA STROBE A V_{IL} loads data on D0-D7 into the Transmitter Holding Register and resets TBMT to a V_{OL}.
(24)	TFS	TRAMSMIT FILL STROBE A V_{IL} loads data on D0-D7 into the Transmitter Fill Register. The character in the Transmitter Fill Register is transmitted whenever a new character is not loaded in the allotted time.
(23)	RSS	RECEIVER SYNC STROBE A V_{IL} loads data on D0-D7 into the Receiver Sync Register. SCR is set to V_{OH} whenever data in the Receiver Shift Register compares with the character in the Receiver Sync Register.
(9)	TBMT	TRANSMIT BUFFER EMPTY A V_{OH} indicates the data in the Transmitter Holding Register has been transferred to the Transmitter Shift Register and new data may be loaded. TBMT is reset to V_{OL} by a V_{IL} on $\overline{TDS}$. A V_{IH} on RESET sets TBMT to a V_{OH}. TBMT is also multiplexed onto the RD7 output (26) when $\overline{SWE}$ is at V_{IL} and $\overline{RDE}$ is at V_{IH}.
(6)	TSO	TRANSMITTER SERIAL OUTPUT Data entered on D0-D7 are transmitted serially, least significant bit first, on TSO at a rate equal to the Transmit Clock frequency, TCP. Source of the data to the transmitter shift register is the Transmitter Holding Register or Transmitter Fill Register.
(36)	TCP	TRANSMIT CLOCK Data is transmitted on TSO at the frequency of the TCP input in a NRZ format. A new data bit is started on each negative to positive transition (V_{IL} to V_{IH}) of TCP.
(26) (27) (28) (29) (30) (31) (32)	RD7 RD6 RD5 RD4 RD3 RD2 RD1	RECEIVED DATA OUTPUTS RDO-RD7 contain data from the Receiver Output Register or selective status conditions depending on the state of $\overline{SWE}$ and $\overline{RDE}$ per the following table:

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MPU/ACIA INTERFACE (CONT'D)

Pin	Label	Function

(33) RD0

(34)	(35)	(33)	(32)	(31)	(30)	(39)	(28)	(27)	(26)
$\overline{SWE}$	$\overline{RDE}$	RD0	RD1	RD2	RD3	RD4	RD5	RD6	RD7
V_{IL}	V_{IL}	X	X	X	X	X	X	X	X
V_{IL}	V_{IH}	RDA	ROR	RPE	SCR	V_{OL}	V_{OL}	FCT	TBMT
V_{IH}	V_{IL}	DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7
V_{IH}	V_{IH}	X	X	X	X	X	X	X	X

X Output is in the OFF or Tri-State condition
DB0 LSB of Receiver Output Register
DB7 MSB of Receiver Output Register
The two unused outputs are held at V_{OL} in the output status condition.

(35) $\overline{RDE}$ — RECEIVE DATA ENABLE A V_{IL} enables the data in the Receiver Output Register onto the output data lines RD0–RD7. The trailing edge (V_{IL} to V_{IH} transition) of $\overline{RDE}$ resets RDA to the V_{OL} condition.

(7) FCT — FILL CHARACTER TRANSMITTED A V_{OH} on FCT indicates data from the Transmitter Fill Register has been transferred to the Transmitter Shift Register.
FCT is reset to V_{OL} when data is transferred from the Transmitter Holding Register to the Transmitter Shift Register, or on the trailing edge (V_{IL} to V_{IH}) of the SWE pulse, or when RESET is V_{IH}.
FCT is multiplexed onto the RD6 output (27) when $\overline{SWE}$ is at V_{IL} and $\overline{RDE}$ is at V_{IH}.

(25) RSI — RECEIVER SERIAL INPUT Serial data is clocked into the Receiver Shift Register, least significant bit first, on RSI at a rate equal to the Receive Clock frequency RCP.

(37) RCP — RECEIVE CLOCK Data is transferred from RSI input to the Receiver Shift Register at the frequency of the RCP input. Each data bit is entered on the positive to negative transition (V_{IH} to V_{IL}) of RCP.

(12) RDA — RECEIVED DATA AVAILABLE A V_{OH} indicates a character has been transferred from the Receiver Shift Register to the Receiver Output Register.
RDA is reset to V_{OL} on the trailing edge (V_{IL} to V_{IH} transition) of $\overline{RDE}$, by a V_{IL} on $\overline{RR}$ or a V_{IH} on RESET.
RDA is multiplexed onto the RD0 output (33) when $\overline{SWE}$ is V_{IL} and $\overline{RDE}$ is V_{IH}.

(8) SCR — SYNC CHARACTER RECEIVED A V_{OH} indicates the data in the Receiver Shift Register is identical to the data in the Receiver Sync Register.
SCR is reset to a V_{OL} when the character in the Receiver Shift Register does not compare to the Receiver Sync Register, on the trailing edge (V_{IL} to V_{IH} transition) of $\overline{SWE}$, by a V_{IL} on $\overline{RR}$ or a V_{IH} on RESET.
SCR is multiplexed onto the RD3 output (30) when $\overline{SWE}$ is a V_{IL} and $\overline{RDE}$ is V_{IH}.

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MPU/ACIA INTERFACE (CONT'D)

Pin	Label	Function
(34)	$\overline{SWE}$	STATUS WORD ENABLE A V_{IL} enables the internal status conditions onto the output data lines RD0–RD7. The trailing edge of $\overline{SWE}$ pulse resets FCT, ROR, RPE, and SCR to V_{OL}.
(11)	ROR	RECEIVER OVERRUN A V_{OH} indicates data has been transferred from the Receiver Shift Register to the Receiver Output Register when RDA was still set to V_{OH}. The last data in the Output Register is lost. ROR is reset by the trailing edge (V_{IL} to V_{IH}) of $\overline{SWE}$, a V_{IL} on $\overline{RR}$, a V_{IH} on RESET or a V_{OL} to V_{OH} transition of RDA. ROR is multiplexed onto the RD1 output (32) when $\overline{SWE}$ is V_{IL} and $\overline{RDE}$ is V_{IH}.
(10)	RPE	RECEIVER PARITY ERROR A V_{OH} indicates the accumulated parity on the received character transferred to the Output Register does not agree with the parity selected by POE. RPE is reset with the next received character with correct parity, the trailing edge (V_{IL} to V_{IH}) of $\overline{SWE}$, a V_{IL} on $\overline{RR}$ or a V_{IH} on RESET. RPE is multiplexed onto the RD2 output (31) when $\overline{SWE}$ is V_{IL} and $\overline{RDE}$ is V_{IH}.
(13)	$\overline{RR}$	RECEIVER RESTART A V_{IL} resets the receiver section by clearing the status RDA, SCR, ROR, and RPE to V_{OL}. The trailing edge of $\overline{RR}$ (V_{IL} to V_{IH}) also puts the receiver in a bit transparent mode to search for a comparison, each bit time, between the contents of the Receiver Shift Register and the Receiver Sync Register. The number of data bits per character for the comparison is set by NDB1 and NDB2. After a compare is made SCR is set to V_{OH}, the sync character is transferred to the Receiver Output Register, and the receiver enters a word synchronous mode framing an input character each word time. NOTE: Parity is not checked on the first sync character but is enabled for every succeeding character.
(39)	NDB1	NUMBER DATA BITS The number of Data Bits per character are determined by NDB1 and NDB2. The number of data bits does not include the parity bit. NDB2 / NDB1 / CHARACTER LENGTH V_{IL} / V_{IL} / 5 Bits V_{IL} / V_{IH} / 6 Bits V_{IH} / V_{IL} / 7 Bits V_{IH} / V_{IH} / 8 Bits For character lengths less than 8 bits, unused inputs are ignored and unused outputs are held to V_{OL}. Data is always right justified with D0 and RD0 being the least significant bits.
(3)	NPB	NO PARITY BIT A V_{IH} eliminates generation of a parity bit in the transmitter and checking of parity in the receiver. With parity disabled, the RPE status bit is held at V_{OL}.
(4)	POE	PARITY ODD/EVEN A V_{IH} directs both the transmitter and receiver to operate with even parity. A V_{IL} forces odd parity operation. NPB must be VIL for parity to be enabled.
(5)	$\overline{CS}$	CONTROL STROBE A V_{IL} loads the control inputs NDB1, NDB2, POE, and NPB into the Control Register. For static operation, $\overline{CS}$ can be tied directly to ground.

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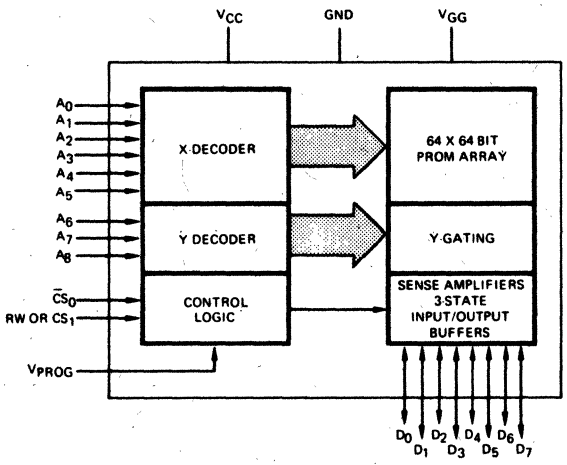
S5204A

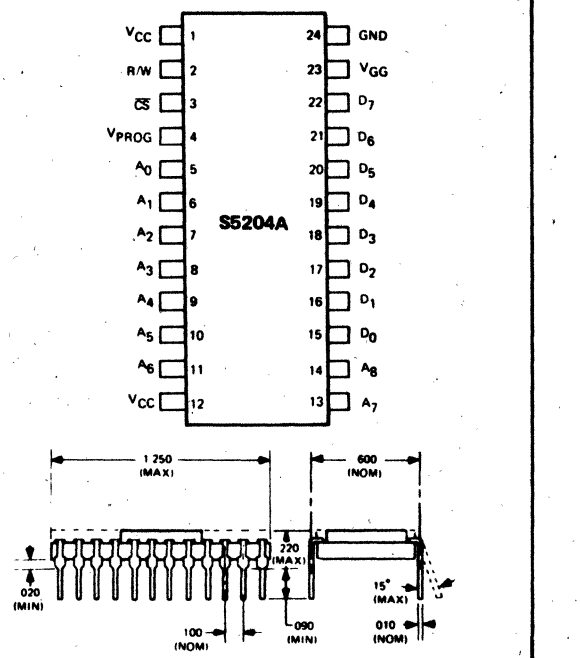
512 X 8 BIT
ERASABLE AND
ELECTRICALLY REPROGRAMMABLE
READ ONLY MEMORY

AMERICAN MICROSYSTEMS, INC.

ADVANCED PRODUCT DESCRIPTION



BLOCK DIAGRAM



PIN/PACKAGE CONFIGURATION

FEATURES

- On-Board Programmability
- Fast Access Time - 750 ns Max.
- High Speed Programming – Less than 1 Minute for all 4096 Bits
- Programmed with R/W, CS and V_{PROG} Pins
- Completely TTL Compatible – Excluding the V_{PROG} Pin
- Ultraviolet Light Erasable - Less than 10 Minutes
- Static Operation – No Clocks Required
- Three-State Data I/O
- Standard Power Supplies +5V and –12V
- Mature P-Chan Process

FUNCTIONAL DESCRIPTION

The S5204A is a high speed, static, 512 x 8 bit, erasable and electrically programmable read only memory designed for use in bus-organized systems. Both input and output are TTL compatable during both read and write modes. Packaged in a 24 pin hermetically sealed dual in-line package the bit pattern can be erased by exposing the chip to an ultra-violet light source through the transparent lid, after which a new pattern can be written.

TYPICAL APPLICATIONS

- ROM Program Debugging
- Code Translation
- Microprogramming
- Look-up Tables
- Random Logic Replacement
- Programmable Waveforms
- Character Generation
- Electronic Keyboards

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FAIRCHILD F8 MICROPROCESSOR

Fairchild's F8 has everything under control

- CPU, I/O and memory specifically tailored to control applications;
- 2-chip minimum configuration for lowest cost;
- Full line of software support insures minimal development time and trouble;
- Epoxy encapsulated packaging insures reliability;
- Systems can be modularly expanded to meet changing control requirements.

F8 Building Blocks: The F8 is a family of LSI integrated circuits with a carefully planned architecture to minimize system cost through minimum chip count. The family consists of a central processing unit, program storage units, memory interfaces and peripheral I/O control devices.

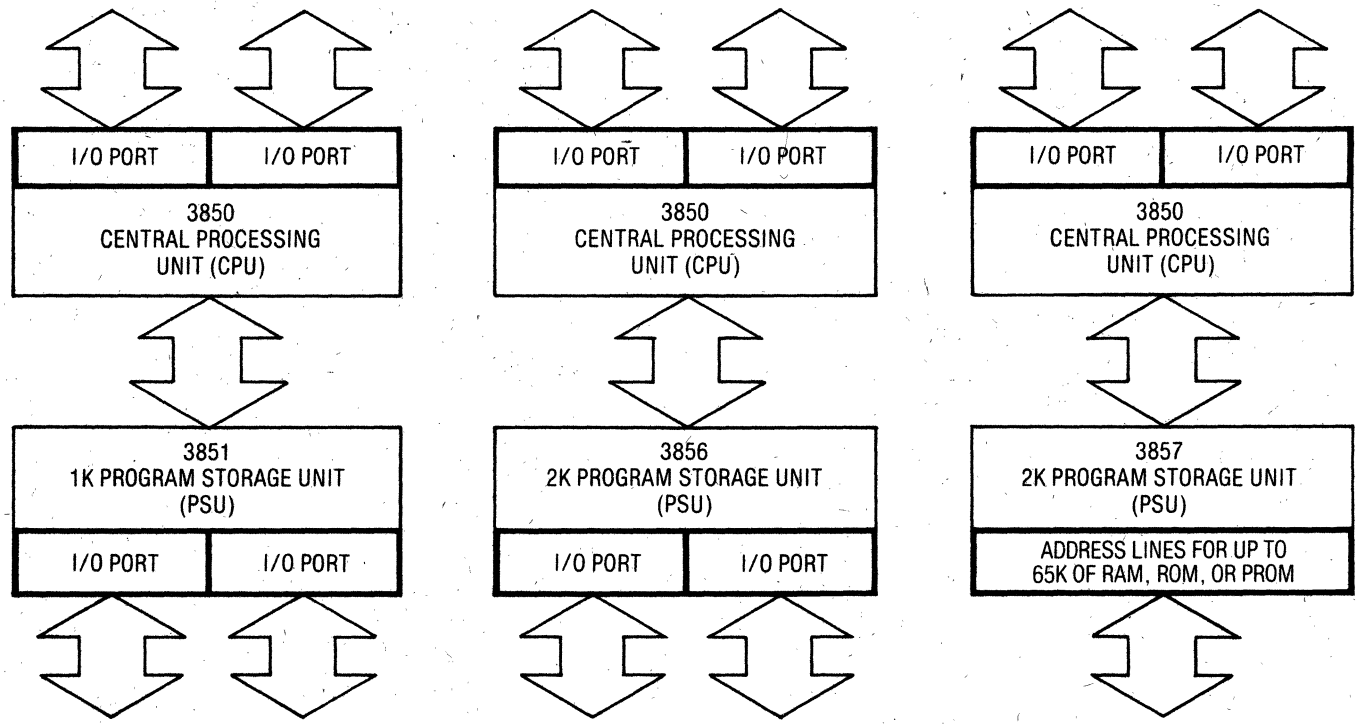
Lowest Cost by Lowest Chip Count: The F8 has the lowest circuit count regardless of memory requirements—the 3850 contains 64 bytes of RAM on-chip; with the 3851 you get an additional 1K x 8 of ROM; with the 3856 an additional 2K. For more complex control applications, consider a system comprising a 3850 cpu and a 3857 program storage unit—2K of ROM plus the ability to interface with up to 65K of memory storage—RAM, ROM or PROM.

In any configuration, a two-chip F8 system can replace the hundreds of TTL packages and discrete components required for applications already under electronic control, and can easily be used to effectively replace existing electromechanical control configurations.

Lower Manufacturing Costs: The reduced-circuits implementation of the F8 means fewer parts to procure, test and assemble. It also means you need less board space. The result—lower costs from purchasing through manufacturing.

More Reliable Systems: Reliability is directly related to parts count and the number of interconnects. The F8's unique architecture keeps both down to a minimum.

Shorter Design Cycles: The F8 Formulator Development System makes the most of your engineering and development time. It allows you to efficiently develop your hardware and software. This means your new products can get to the market faster.



THE F8 2 CHIP MICROPROCESSOR SPECTRUM

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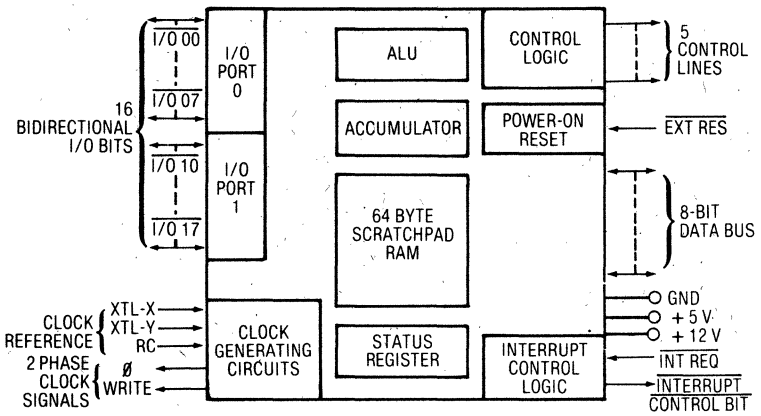
3850 Central Processing Unit

Fairchild's F8 Central Processing Unit (CPU) contains all of the functions of an ordinary central processor and adds some time and money saving features uniquely its own. For instance, the 64 bytes of scratchpad RAM memory already included on the F8 CPU eliminate the need for external RAM circuits in many applications. Clock and power-on-reset circuitry, normally requiring additional integrated circuit packages, are included on-chip. Fairchild's CPU also contains 16 bits of fully bidirectional input and output lines internally latched (for storing output data) and capable of driving a standard TTL load.

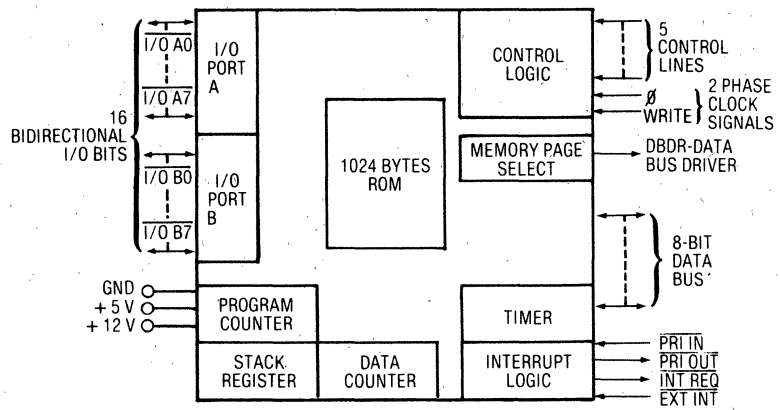


3850 CPU BLOCK DIAGRAM

3851 Program Storage Unit

It is important to note that Fairchild's Program Storage Unit (PSU) is not just a conventional Read Only Memory. In addition to containing 1024 bytes of mask programmable ROM for program and constant storage, the F8 PSU includes the addressing logic for memory referencing, a Program Counter, an Indirect Address Register (the Data Counter) and a Stack Register. A complete vectored interrupt level, including an external interrupt line to alert the central processor, is provided. All of the logic necessary to request, acknowledge and reset the interrupt is on the F8 PSU. The 8-bit Programmable Timer is especially useful for generating real time delays. The PSU has an additional 16 bits of TTL compatible, bidirectional, fully latched I/O lines.

Systems requiring more program storage may be expanded by adding more PSU circuits. For example, one F8 CPU and three F8 PSUs will produce a microprocessor system complete with 64 bytes of RAM, 3072 bytes of ROM, 64 I/O bits, three interrupt levels, and three programmable timers. This complete system will require only four IC packages.



3851 PSU BLOCK DIAGRAM

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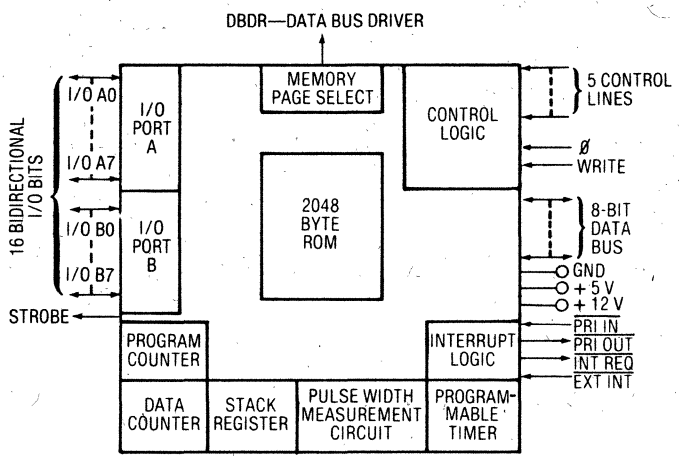
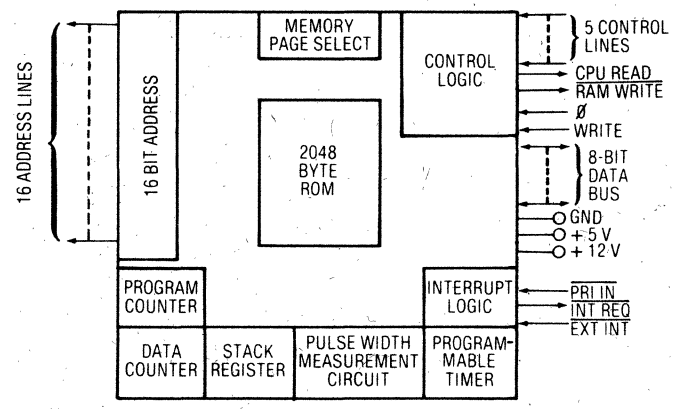
3856 Program Storage Unit



3856 PSU BLOCK DIAGRAM

3857 Program Storage Unit/ Memory Interface



3857 PSU/MI BLOCK DIAGRAM

Both the 3856 and 3857 contain not only 2048 x 8 bytes (16K bits) of Read Only Memory for program and permanent data storage, but also memory addressing logic, timer and interrupt functions, and pulse-width measurement capability.

The on-chip logic contains four 16-bit address registers (two program counters, PC0 and PC1, and two Data Counters, DC0 and DC1).

The timer is a pre-settable 8-bit binary counter which can be started and stopped by input-pin level transitions or program control. The count rate is selectable under program control (1, 4, 8 or 32 μs, offering either up to 1 μs timing accuracy or up to 8 ms time-out period). The state of the counter can be read back into the CPU, which allows accurate pulse width measurement. Both timer and external interrupt can be enabled simultaneously.

The 3856 and 3857 differ in the utilization of their I/O pins. The 3856 PSU contains two 8-bit bidirectional I/O ports (equivalent to the 3851) plus a strobe output which is active whenever its associated port is being used. The strobe output can be used for handshaking control of peripheral logic. The 3857 PSU has no I/O ports, but provides 16 address lines and two control signals to drive external memory (RAM, ROM or PROM).

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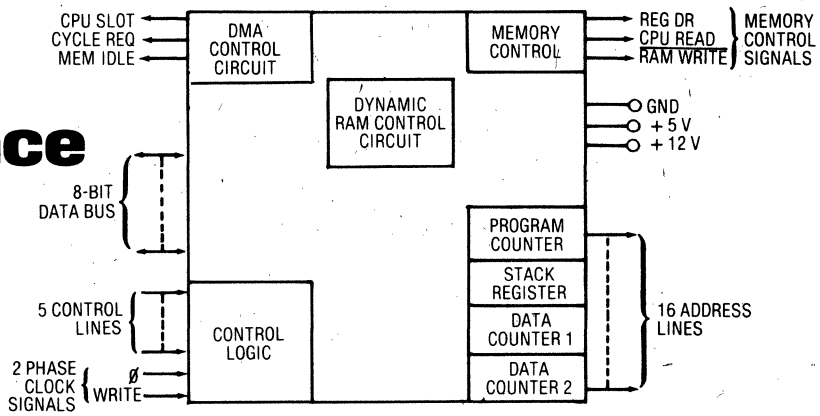
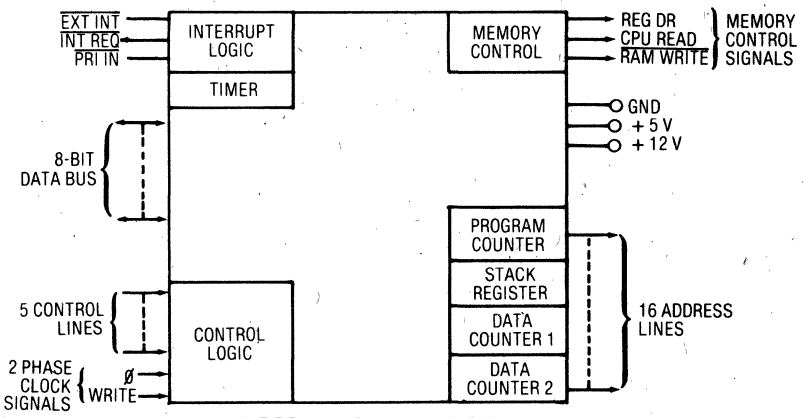
3852/3853 Memory Interface

The Static Memory Interface (SMI) contains a program counter, data counter, an auxiliary data counter, stack register, incrementer/adder, a programmable timer, and an 8-bit data port in addition to the 16-bit address bus for communication with external memory. The 3853 may be used with the CPU and PROM to provide an F8 system that requires no ROM. It may also be used in conjunction with the 3851 PSU circuits.

The Dynamic Memory Interface (DMI) provides an appropriate interface for either static or dynamic memory components. Dynamic memory refresh cycles and DMA transfers are performed without slowing the central processor. The DMI also contains a program counter, data counter, an auxiliary data counter, stack register, increment/adder, and an 8-bit data port in addition to the 16-bit address bus for communication with external memory. The DMI may also be used solely with the CPU, or in conjunction with the 3851 PSU device.



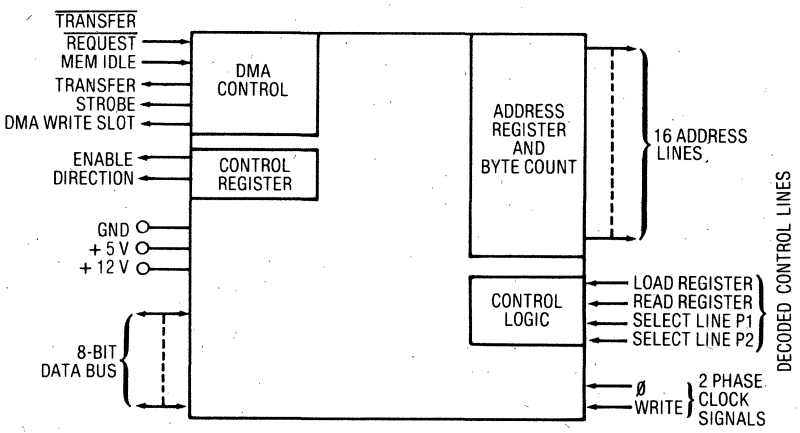
3852 BLOCK DIAGRAM



3853 SMI BLOCK DIAGRAM

3854 Direct Memory Access

Fairchild's Direct Memory Access (DMA) device sets up a high speed data path to link F8 memory with peripheral electronics. The F8 DMA circuit, when working in conjunction with the F8 DMI, does not require overhead electronics to keep track of memory addresses, bytes transferred and handshaking signals. The data transfer is initiated by the CPU under program control. Once started, the DMA transfer will continue without CPU intervention. The CPU can sense the enable line of the DMA to determine the completion of a transfer. The entire DMA transfer will take place without halting the central processor.



3854 DMA BLOCK DIAGRAM

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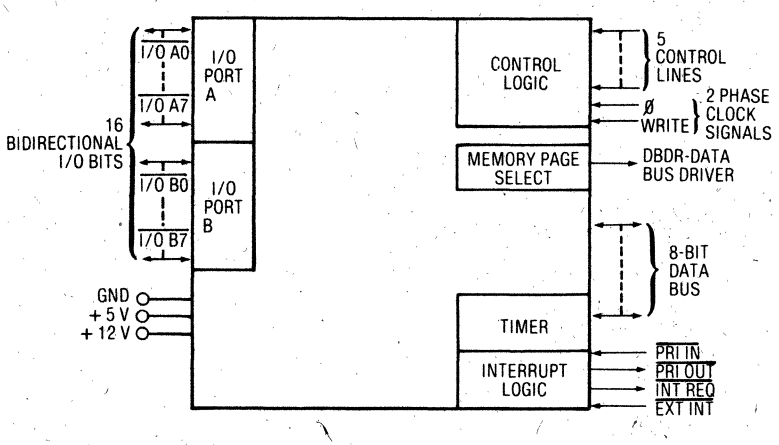
3861 Peripheral Input/Output Circuit

Designed for use in F8-based systems that require the I/O capabilities and interrupt functions of the 3851 program storage unit but not the ROM storage that goes with it, the 3861 peripheral input/output circuit provides two 8-bit I/O ports, logic to handle an external interrupt, and a programmable interval timer. The 3861 can be combined with the 3853 to create a microcomputer system that requires no ROM. An 8-bit bi-directional data bus transfers data between the 3861 and the 3850 CPU. There are five versions of the 3861 available, each with its own set of pre-assigned I/O port addresses and interrupt vectors.



3861 PERIPHERAL INPUT/OUTPUT CIRCUIT BLOCK DIAGRAM

F8 Applications Spectrum

The two-chip F8 microprocessor system has proven itself to be one of the most cost/effective alternatives open to control-system designers, and to meet varied control requirements, it is available in several two-chip configurations. You can connect the F8's 3850 CPU to the 3851 program storage unit for up to 1K of ROM, to the 3856 program storage unit which offers up to 2K of 8-bit ROM, or to the 2K 3857 (2K of ROM plus access to up to 65K of read/write RAM memory). No matter which two-chip configuration you use, a two-chip F8 can add inexpensive, precision control for:

- gas pumps;
- taxi meters;
- digital thermometers;
- electronic displays;
- automotive ignition, braking and dash-board systems;
- vending machines;
- electronic scales; microwave ovens and other appliances;
- cash registers;
- traffic signals;
- PABX;
- Electronic games; Speciality calculators and many more.

In fact there's only one limit to the number of places where the F8 can be put to use—your imagination.

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F8 Instruction Set Summary

The F8 instruction set contains over 60 different instructions which may be subdivided into 10 categories: Accumulator, Scratchpad Register, Indirect Scratchpad Address Register, Memory Reference, Data Counter, Status Register, Program Counter, Branch, Interrupt Control and Input/Output instructions. Because 55% of the F8 instructions are only one byte long, programs are short and memory requirements significantly reduced. An alphabetic listing of the instructions is shown below. The following pages contain a complete description of the F8 instructions, including the cycle time. Each cycle is 2 μs for a system with a 2 MHz clock frequency.

F8 ADDRESSING MODES

The F8 instruction set has eight modes of referencing either I/O, CPU registers or bulk memory.

Implied Addressing

The data for this one-byte instruction is implied by the actual instruction. For example, the POP instruction automatically implies that the content of the Program Counter will be set to the value contained in the Stack Register.

Direct Addressing

In these two-byte instructions, the address of the operand is contained in the second byte of the instruction. The Direct Addressing mode is used in the Input/Output class of instructions.

Short Immediate Addressing

Instructions whose addressing mode is Short Immediate have the instruction op code as the first four bits and the operand as the last four bits. They are all one-byte instructions.

Long Immediate Addressing

In these two-byte instructions, the first instruction byte is the op code and the second byte is the 8-bit operand.

Direct Register Addressing

This mode of addressing may be used to directly reference the Scratchpad Registers. By including the register number in the one-byte instruction, 12 of the 64 Scratchpad Registers may be referenced directly.

Indirect Register Addressing

All 64 Scratchpad Registers may be indirectly referenced, using the Indirect Scratchpad Register in the CPU. This 6-bit register, which acts as a pointer to the scratchpad memory, may either be incremented, decremented, or left unchanged while accessing the scratchpad register.

Indirect Memory Addressing

A 16-bit Indirect Address Register, the Data Counter, points to either data or constants in bulk memory. A group of one-byte instructions is provided to manipulate this area of memory. These instructions imply that the Data Counter is pointing to the desired memory byte. The Data Counter is self-incrementing, allowing for an entire data field to be scanned and manipulated without requiring special instructions to increment its content. The memory interface circuit contains two interchangeable data counters.

Relative Addressing

All F8 Branch Instructions use the relative addressing mode. Whenever a branch is taken, the Program Counter is updated by an 8-bit relative address contained in the second byte of the instruction. A branch may extend 128 locations forward or 127 locations back.

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F8 Microprocessor Support Documentation

F8 User's Guide
This book is an in-depth description of the F8 components. It includes a detailed specification of each device including signal timing. System configurations are also discussed.

F8 Guide to Programming
The Guide to Programming is an introduction to machine language and assembly language programming for the F8 microprocessor system.

FORMULATOR User's Guide
This book describes how to use the Fairchild FORMULATOR system to convert source programs, written in F8 assembly language, into object programs which can be executed by a predefined F8 microcomputer system.

FORMULATOR Hardware Reference Manual
This book presents an in-depth technical description of the F8 FORMULATOR System, its component subsystems and optional capabilities available through subsystem module options. The technical description includes general functional characteristics, theory of operation and detailed description of interface signals.

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Fairchild F8 Microprocessor

POWER REQUIREMENTS: $V_{DD} = +5.0\,V \pm 5\%$; $V_{GG} = +12.0\,V \pm 5\%$; $V_{SS} = 0\,V$; $T_A = 0°C$ to $70°C$; $f = 2\,MHz$

PART TYPE	SYMBOL	PARAMETER	TYP	MAX	UNITS	TEST CONDITIONS (Outputs Unloaded)
3850	I_{DD} I_{GG}	V_{DD} Current V_{GG} Current	30 15	80 25	mA mA	2 MHz
3851	I_{DD} I_{GG}	V_{DD} Current V_{GG} Current	30 10	70 18	mA mA	2 MHz
3861	I_{DD} I_{GG}	V_{DD} Current V_{GG} Current	30 10	70 18	mA mA	2 MHz
3856 3857	I_{DD} I_{GG}	V_{DD} Current V_{GG} Current	38 17	90 31	mA mA	2 MHz
3852 3853	I_{DD} I_{GG}	V_{DD} Current V_{GG} Current	35 13	70 30	mA mA	2 MHz
3854	I_{DD} I_{GG}	V_{DD} Current V_{GG} Current	20 15	40 28	mA mA	2 MHz

SIGNAL ELECTRICAL SPECIFICATIONS: $V_{DD} = +5.0\,V \pm 5\%$; $V_{GG} = +12.0\,V \pm 5\%$; $V_{SS} = 0\,V$; $T_A = 0°C$ to $70°C$; $f = 2\,MHz$

SIGNAL NAME (NUMBER, TYPE)	SOURCE OR RECEIVING DEVICE	V_{OH} MIN	V_{IH} MIN	V_{OL} MAX	V_{IL} MAX	TEST CONDITIONS
DATA BUS (8 INPUTS, OUTPUTS)	3850 3851 3852/3 3854 3856/7 3861	3.9	3.5	0.4	0.8	$I_{OH} = -100\,\mu A$ $I_{OL} = 1.6\,mA$
CONTROL BUS (5 OUTPUTS)	3850	3.9		0.4		$I_{OH} = -100\,\mu A$ $I_{OL} = 1.6\,mA$
CONTROL BUS (5 INPUTS)	3851 3852/3 3856/7 3861		3.5		0.8	
I/O PORTS (16 INPUTS, OUTPUTS) STANDARD PULL-UP	3850 3851 3856 3861	2.9 (1 TTL) 3.9 (unloaded)	3.5	0.4	0.8	$I_{OH} = -30\,\mu A$ (unloaded) $I_{OH} = -100\,\mu A$ $I_{OL} = 2\,mA$
CLOCK REFERENCE (INPUT)	3850		4.0		0.8	
SYSTEM CLOCKS (PHI AND WRITE OUTPUTS)	3850	4.0		0.4		$I_{OH} = -10\,\mu A$ $I_{OL} = 1.6\,mA$
SYSTEM CLOCKS (PHI AND WRITE INPUTS)	3851 3852/3 3854 3856/7 3861		4.0		0.8	
RESET (INPUT)	3850		3.5		0.8	$I_{IL} = -1.0\,mA$ max at $V_{IN} = V_{SS}$
INTERRUPT CONTROL BIT (OUTPUT)	3850	3.9		0.4		$I_{OH} = -100\,\mu A$ $I_{OL} = 100\,\mu A$
INTERRUPT REQUEST (INPUT)	3850		3.5		0.8	
INTERRUPT REQUEST (OUTPUT)	3851 3853 3856/7 3861	OPEN DRAIN		0.4		$I_{OL} = 1\,mA$
EXTERNAL INTERRUPT (INPUT)	3851 3853 3856/7 3861		3.5		1.2	
PRIORITY IN (INPUT)	3851 3853 3856/7 3861		3.5		0.8	
PRIORITY OUT (OUTPUT)	3851 3856 3861	3.9		0.4		$I_{OH} = -100\,\mu A$ $I_{OL} = 100$ A
DBDR (OUTPUT)	3851 3856/7 3861	OPEN DRAIN		0.4		$I_{OL} = 2\,mA$
ADDRESS LINES and RAM WRITE (16 OUTPUTS)	3852/3 3854 3857	4.0		0.4		$I_{OH} = -1\,mA$ $I_{OL} = 3.2\,mA$
REGDR (INPUT/OUTPUT)	3852/3	3.9	3.5	0.4	0.8	$I_{OH} = -300\,\mu A$ $I_{OL} = 2\,mA$
CPU READ (OUTPUT)	3852/3	3.9		0.4		
MEM IDLE, CYCLE REQ and CPU SLOT (OUTPUTS)	3852	3.9		0.4		$I_{OH} = -300\,\mu A$ $I_{OL} = 2\,mA$
MEM IDLE (INPUT)	3854		3.5		0.8	
ENABLE, DIRECTION, TRANSFER, DMA WRITE SLOT, STROBE (OUTPUTS)	3854	3.9		0.4		$I_{OH} = -100\,\mu A$ $I_{OL} = 2\,mA$
XFER REQ, P1, P2 (INPUTS)	3854		3.5		0.8	
LOAD REG, READ REG (INPUTS)	3854		3.5		0.8	
I/O PORT OPEN DRAIN	3851 3856		2.9	0.4	0.8	$I_{OL} = 2\,mA$
I/O PORT DRIVER PULL-UP	3856	3.75		0.4		$I_{OH} = -1\,mA$ $I_{OL} = 2\,mA$
STROBE	3856	3.9		0.4		$I_{OH} = -1\,mA$ $I_{OL} = 2\,mA$

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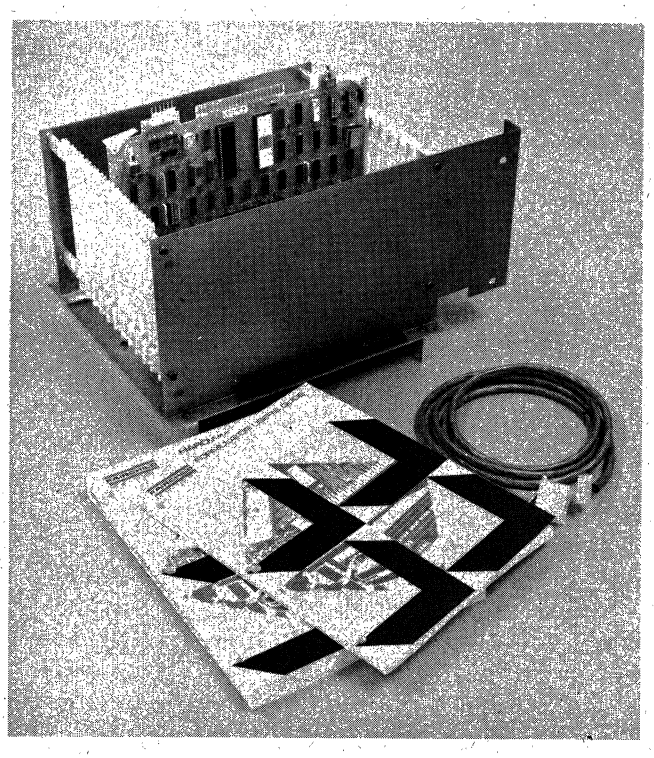
The Formulator Family

The Formulator family of development equipment allows users to match a development system with the requirements and resources at hand. Consisting of a complete range of products, the Formulator family provides the hardware and software necessary to DESIGN F8 Microprocessor based control circuits completely and efficiently. Three products head the Formulator family, the Formulator Mark I, Mark II, and Mark III.

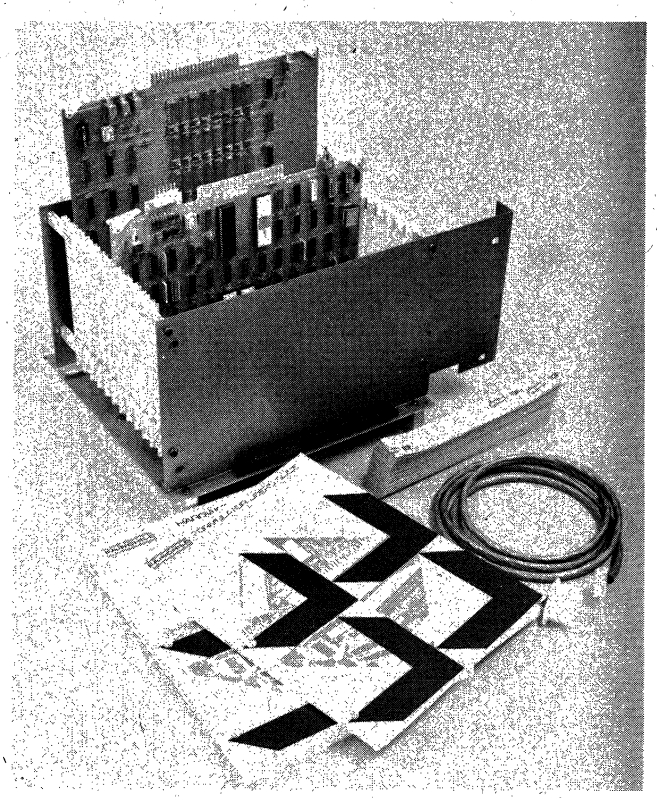
The Formulator Mark I

The Formulator Mark I is a low cost hardware development tool. It comes with the Formulator processor board, card cage, and backpanel. In addition, a peripheral cable and I/O cable kit is supplied. The Mark I has sufficient hardware to allow users to develop and debug a breadboard directly in the system. Software, consisting of the Fairbug Operating System, provides the Mark I with sufficient debug capability to load a program, monitor and alter memory locations, store a program on an external file, and generate a tape suitable for burning PROM memory devices.



The Formulator Mark II

The Formulator Mark II adds a complete Software Operating System to the Mark I. In addition, to the Mark I configuration, the Mark II provides a 16K RAM board and the Formulator Operating System designated FOS. FOS is designed for developing microprocessor based systems. In it is an editor, assembler, and debug package to allow the generation of F8 source code and the creation and checkout of F8 object code.



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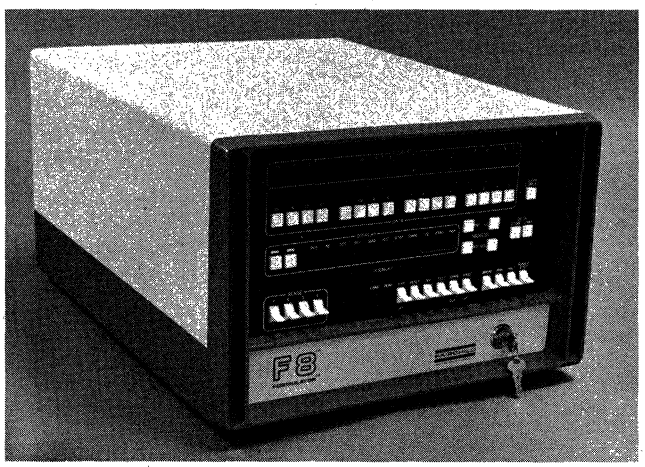
The Formulator Mark III

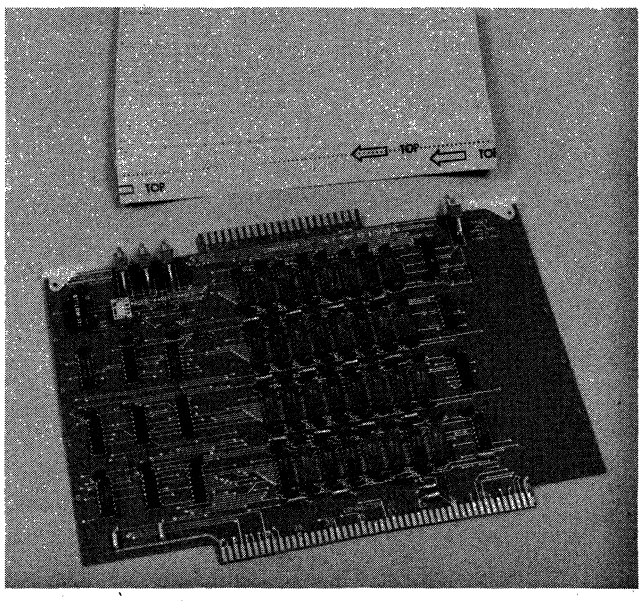
The top of the line in microprocessor development equipment is the Formulator Mark III. In addition to providing standard hardware and software development capabilities, the Mark III adds an intelligent front panel. This allows an important interaction between hardware and software during the debugging operation—the ability to set hardware breakpoints and to select hardware initiated trace functions. The intelligent front panel also allows direct access to register and memory locations within the F8 system. In addition, the front panel performs a self-test operation and an initial program load. The Formulator Mark III is supplied with an attractive cabinet and power supplies.



Growth Packages

The Formulator systems are upwards compatible. The Mark I can be expanded to become a Mark II and, likewise, the Mark II may be grown into a Mark III. This means that with a Formulator system you may enter the microcomputer design at a level which best matches the needs at hand—amount of available money, time, microprocessor experience—and be able to increase the Formulator's capabilities as your needs grow. Two growth packages are available to Formulator owners. Growth Package I converts a Formulator Mark I into a Mark II. This package contains a 16 byte RAM module and a Formulator Mark II operating system. Growth Package II is available for converting a Mark II to a Mark III. Growth II package includes Quad I/O module, communication module, console control module, I/O cable, peripheral cable and Formulator Mark III Operating System. Expansion does not have to occur along the Formulator growth path—Formulator modules are available to expand RAM, PROM, I/O, and communications. So the user can develop a system which is custom suited to the job at hand.

Upwards compatibility also means that your initial investment is preserved. Nothing gets thrown away as your needs and ability grow. When you need more from the Formulator, you can add modules to it. Its ability can grow as fast as your needs grow.



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Micro Pro

Fully Assembled and Tested Microprocessor Evaluation and Development System:

Microprocessor Board

The Micro Pro system contains a complete working F8 microcomputer on a fully assembled and completely tested PC board, a cable to Teletype hook-up, F8 User's Guide, F8 Guide to Programming, and Micro Pro User's Manual.

On the board are 1K bytes of static RAM, 32 Input/Output bits—all bidirectional and TTL compatible, two levels of interrupts, two programmable timers, all the necessary control circuits, and 64 bytes of scratchpad RAM.

Built-in software

The preprogrammed, 1K byte PSU (FAIRBUG) contains a program to save time and effort in designing, loading and debugging your own programs.

With Fairbug you can display or alter memory locations, scratchpad registers, accumulator, status register, program counters, data counters. You can load or punch formatted paper tape; punch paper tape in PROM format; or enter data from TTY keyboard or from 110 to 2400 Baud or by program instruction. Fairbug has a "bootstrap loader" to assist in program loading. Fairbug is a series of subroutines which you can use separately, or as a part of a subroutine library.

Features summary

- Fully assembled
- Completely Tested
- 1K bytes of RAM
- 32 TTL compatible, bidirectional latched I/O
- Fairbug built-in software
- 2 Programmable Timers
- 64 byte scratchpad
- 2 Levels of interrupts

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F8 Options

PCB MODULE OPTIONS

Note: The F8 FORMULATOR has 9 free slots. Each PCB option requires one Formulator slot.

Central Processor Module
- Power on reset.
- 64 scratchpad registers.
- 2 MHz clock operation.
- Four 8-bit I/O Ports.
- 64K address space.
- DMA compatible.
- 1K Byte RAM.
- Teletype Interface Circuit.
- DMA compatible.

Byte Parallel Interface Module
- 8- or 16-bit bidirectional word parallel operation.
- 8-bit data field control.
- All lines high power buffered.
- Switch setable I/O port address, peripheral identification code, and interrupt vector address.
- Interface to line printer, high speed paper tape punchers and readers and a wide variety of programmable instruments.

I/O Light Display Board
- 32 red LEDs indicates status of 32 I/O lines of Quad I/O Module or 16 lines of Processor Module.

Communication Module
- 13 switch selectable BAUD rates.
- Switch selectable I/O port address, interrupt vector, peripheral device identification code.
- Selectable interface to 20 milliamp current loop, RS-232C or differential TTL drive receive.
- Reader/Run Control for Auto-Reader TTY.

Quad I/O Port Module
- Four 8-bit I/O Ports (32 lines).
- Switch selectable Interrupt vector addresses.
- Switch selectable I/O port address and peripheral device identification code.
- Two external interrupts.
- Selectable interrupt priority.

MEMORY OPTIONS

Note: The F8 FORMULATOR has 9 free slots. Each Memory Option requires one FORMULATOR slot.

4K Byte Static RAM Module
- Switch selectable board address.
- Low Power—80 μA/bit.
- Write protect switch allows ROM simulation.

16K Byte RAM Module
- No additional refresh logic required.
- 16K x 8 or 32K x 4 configuration switch or program selectable.

4K Byte PROM Module
- 16 sockets for 93446 PROMs.
- Switch selectable memory page.

16K Byte PROM Module
- 32 sockets for 93448 PROMs.
- Switch selectable memory page.

PROM PROGRAMMER OPTIONS

Prom Programmer
- Software lookup table accommodates device programming parameters—number of words, word length, burn time, wait time, retry conditions, etc.
- Burn pulse amplitude and fuse time are manually adjustable.
- Can program:

93436	2704
93446	2708
93438	
93448	

- Handles fuseable link or ultraviolet erasable.
- Supplied with Socket Boards for 93436 and 93438.

F8 FORMULATOR APPLICATION OPTIONS

FORMULATOR Base Board and Card Cage
- 13 slots including nine general purpose and four for CPU and console.

Universal Breadboard
- Accepts 14, 16, 18, 22, 24 and 40 pin packages. This board will accommodate 44 16-pin packages.

Extender Board

F8 SOFTWARE

F8 Cross Assembly and Cross Simulator Programs are available in Fortran IV for both large (47K bytes or larger) and medium (34K bytes or larger) size computers. The Cross Assembler and Simulator are combined on single magnetic tapes and are available for both batch processing or interactive data processing systems. In addition, a Fortran IV Cross Assembler is available for use on minicomputers with a word size of 16 bits or larger.
- Cross Assembler/Simulator for large computer (47K bytes up)—Batch processed.
- Cross Assembler/Simulator for medium computer (34K bytes up)—Batch processed.
- Cross Assembler/Simulator for large computer (47K bytes up)—Interactive.
- Cross Assembler/Simulator for medium size computer (34K bytes up)—Interactive.
- Cross Assembler for Minicomputer.

Additional information about Formulator systems and the F8 microprocessor is available from the Micro Systems Division, 1725 Technology Drive, San Jose, California 95110. (408) 998-0123.

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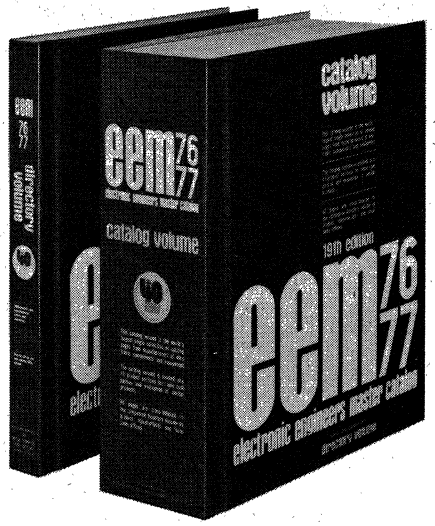

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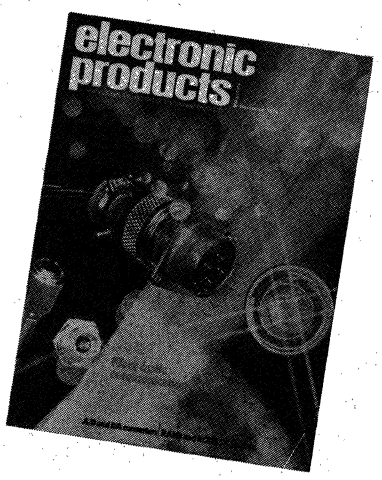

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INTRODUCTION

HM6100 MICROPROCESSOR

The HM-6100 is a single address, fixed word length, parallel transfer microprocessor using 12-bit, two's complement arithmetic. The processors recognize the instruction set of Digital Equipment Corporation's PDP8/E minicomputer. The internal circuitry is completely static and is designed to operate at any speed between DC and the maximum operating frequency. Two pins are available to allow for an external crystal thereby eliminating the need for clock generators and level translators. The crystal can be removed and the processor clocked by an external clock generator. A 12-bit memory-accumulator ADD instruction, using a +5 volt supply, is performed in 5μ sec by the HM-6100, in 6μ sec by the HM-6100C and in 2.5μ sec by the HM-6100A using a +10 volt supply. The device design is optimized to minimize the number of external components required for interfacing with standard memory and peripheral devices.

FEATURES

DESIGN
- Silicon Gate Complementary MOS
- Fully Static-0 to 8 MHz
- Single Power Supply
  - HM-6100/C V_{cc} = 5 volts
  - HM-6100A V_{cc} = 10 volts
- Crystal Controlled On Chip Timing
- Low Power Dissipation < 10 mW @ 4 MHz @ 5 volts
- Single Power Supply 4V ≤ V_{cc} ≤ 11V
- TTL Compatible at 5 Volts
- Excellent Noise Immunity
- −55°C to +125°C Operation

ARCHITECTURAL
- Executes PDP-8/E, Instruction Set
- Direct, Indirect, and Autoindexed Memory Addressing
- 12-Bit Memory Accumulator ADD Instruction
  - HM-6100 5μsec @ +5 volts/4.0 MHz
  - HM-6100A 2.5μsec @ +10 volts/8.0 MHz
  - HM-6100C 6μsec @ +5 volts/3.3 MHz
- Input-Output Instruction
  - HM-6100 8.5μsec @ +5 volts/4.0 MHz
  - HM-6100A 4.25μsec @ +10 volts/8 MHz
  - HM-6100C 10.2μsec @ +5 volts/3.3 MHz
- Single-Clock, Single-Instruction Capability
- Direct Memory Access (DMA)
- Interrupt
- Dedicated Control Panel Features

INTERFACE
- Memory—Any Speed
- Control Panel
- Switch Register
- Asynchronous CPU—Memory and CPU—Device Communication
- 64 I/O Devices with PDP-8/E Compatible Interface
- Device Controlled Input-Output
- All Control Signals Produced By The CPU
- Power-on Initialize

APPLICATIONS

- Intelligent Computer Terminals
- POS Terminals
- Portable Terminals
- Aerospace/Satellite System
- Automotive Systems
- Remote Data Acquisition Systems
- Process Control
- Instrumentation
- Medical Electronics
- Displays
- Traffic Control
- Navigation

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PDP-8/E COMPATIBILITY

The HM-6100 and the PDP-8/E* of Digital Equipment Corporation are software compatible. The basic PDP-8/E paper-tape software system supplied by Digital Equipment Corporation will operate properly with the HM-6100. This basic software package includes Binary Loaders, PAL III Assembler, Symbolic Editor, Dynamic Debugging Technique (DDT), Octal Debugging Technique (ODT), 23 Bit Floating Point Package and FOrmula CALculator (FOCAL)*. The HM-6100 will execute the complete set of CPU diagnostics for PDP-8/E.

Since the bus structure of the HM-6100 can be adapted to provide a subset of the PDP-8/E OMNIBUS* signals, as shown in Figure 22, all programmed I/O interfaces for the PDP-8E, for example, Teletype, Papertape Reader/Punch, etc., will operate with the HM-6100 without any hardware or software modification.

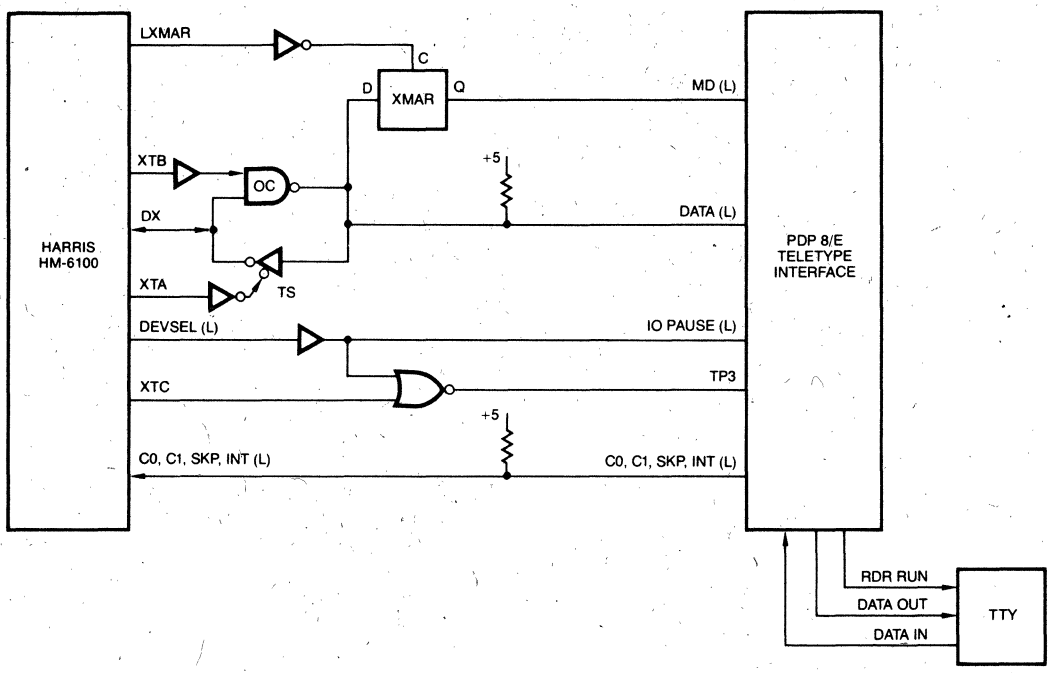
The Direct Memory Access, DMA, structure of the HM-6100 and PDP-8/E are different, the HM-6100 DMA structure is similar to the PDP-8 1-CYCLE BREAK, but not compatible.

The HM-6100 handles 4K words of memory directly. Like the PDP-8/E, an external Extended Memory Control element can be used to extend the addressing space up to 32K. All necessary control and timing signals to implement the memory extension controller are generated by the HM-6100.

The Extended Arithmetic Element, EAE, and the User Flag, UF, processor options of the PDP-8/E cannot be used with the HM-6100. The EAE is used for hardwired Multiply/Divide and the UF for timesharing.

The HM-6100 treats the Control Panel as a programmed I/O device with certain special features. The Control Panel has a dedicated INT request line to the HM-6100 and the control panel program can reside in a separate memory, distinct from the normal program memory. The control panel service routine can be made transparent to the user and the user program can occupy the entire 4K of main memory. The bootstrap routines may also reside in the dedicated control panel memory. Unlike the PDP-8/E, the HM-6100 bootstrap routines and the loaded user programs, can, therefore, share common address space.

FIGURE 22



EXAMPLE OF A PDP-8/E PROGRAMMED I/O PERIPHERAL INTERFACE

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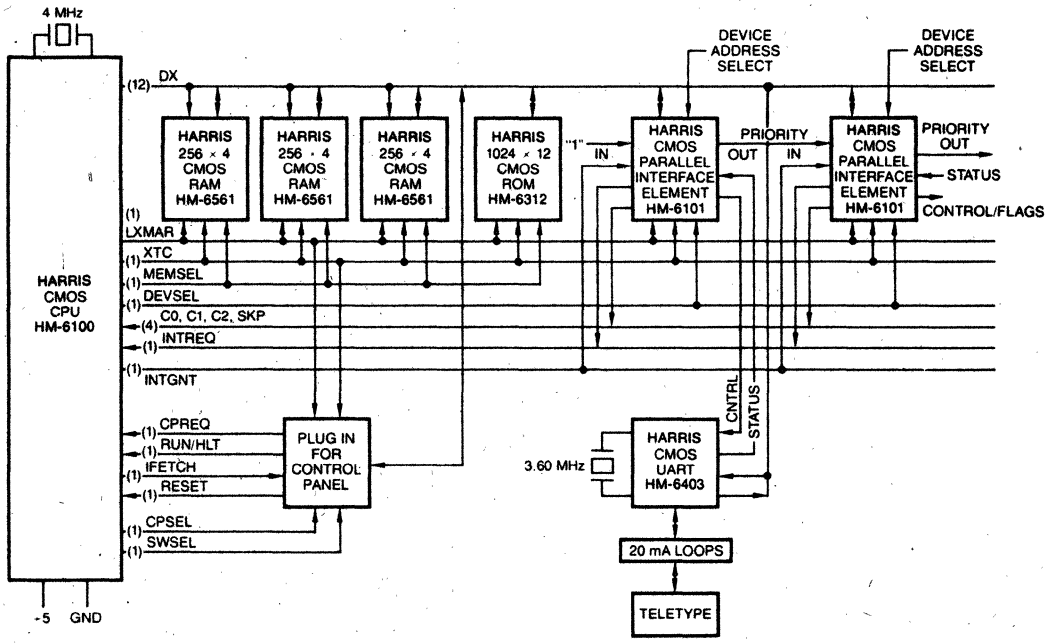
APPLICATIONS

ALL CMOS SYSTEM

The HM-6100 microprocessor family provides for the capability of building an all CMOS system with no additional support components. The CMOS RAM devices are organized 1024 x 1 (HM-6508/18), or 256 x 4 (HM-6551/6561). They have internal address latches and operate synchronously with an address strobe. A 1024 x 12 bit mask programmable CMOS ROM (HM-6312) is also provided. The HM-6402/6403 is an industry standard UART with the option of operating directly from a high frequency crystal. The HM-6101, Parallel Interface Element (PIE), provides all the signals necessary to communicate with an external device including a vectored priority interrupt chain. For example, a parallel Teletype interface can be designed with only two logic elements—the HM-6101 for control and the HM-6403 for data handling. The dynamic power dissipation of the CMOS system will be less than 60mW at +5 volts. (Figure 23.)

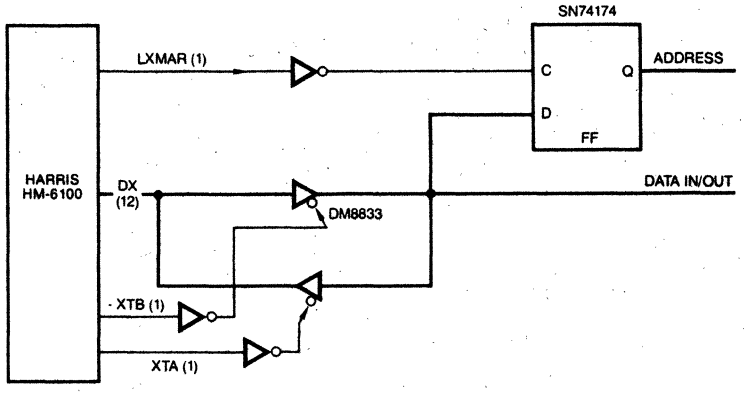
FIGURE 23



GENERAL PURPOSE HM-6100 SYSTEM

A few auxiliary circuits are necessary to permit the HM-6100 to be operational in a general purpose environment. They include transceivers (DM8833) to buffer the DX lines, address latches (SN74174) and buffers for control lines. The HM-6100 requires only 6 additional packages to interface with standard bipolar or MOS RAM's, P ROM's or FPLA's. (Figure 24.)

FIGURE 24



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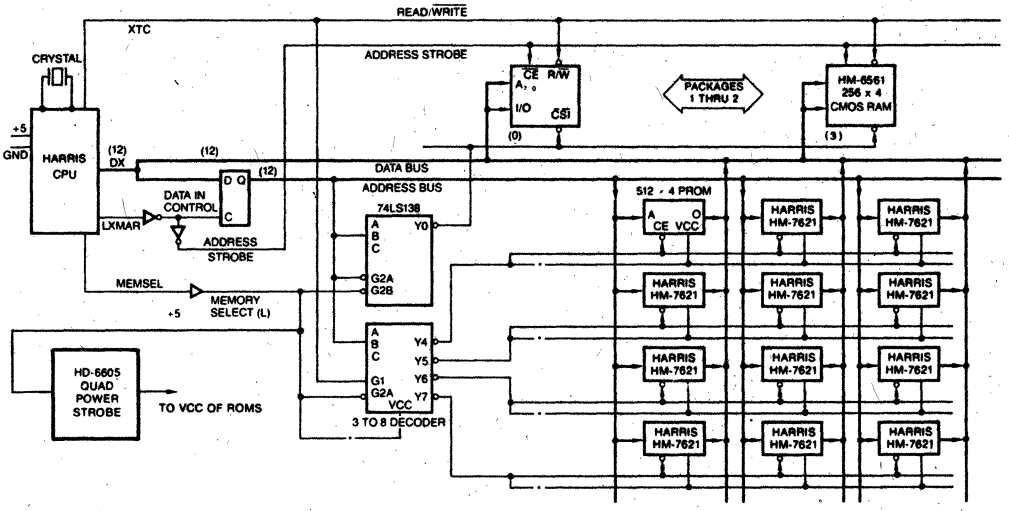
256 × 12 RAM, 2K × 12 PROM MEMORY SYSTEM

A low power nonvolatile memory system with extremely low standby power requirements can be constructed as shown below. A 256 × 12 RAM, 2K × 12 P ROM organization seems to be sufficient for typical microprocessor applications. Provisions are made, however, to expand the RAM-P ROM capacity up to 4K words. The P ROM devices are power strobed with HD-6605's. The CMOS RAM's have extremely low quiescent power requirements, less than 300 μW for a 256 × 12 array, and they can be made nonvolatile with an inexpensive battery backup. The system designer can reduce memory power dissipation considerably with CMOS RAM's and power strobed P ROM's since the memory utilization of microprocessors is typically less than 30%. The power dissipation of the system shown below is less than 0.5watts at 5 volts. (Figure 25.)

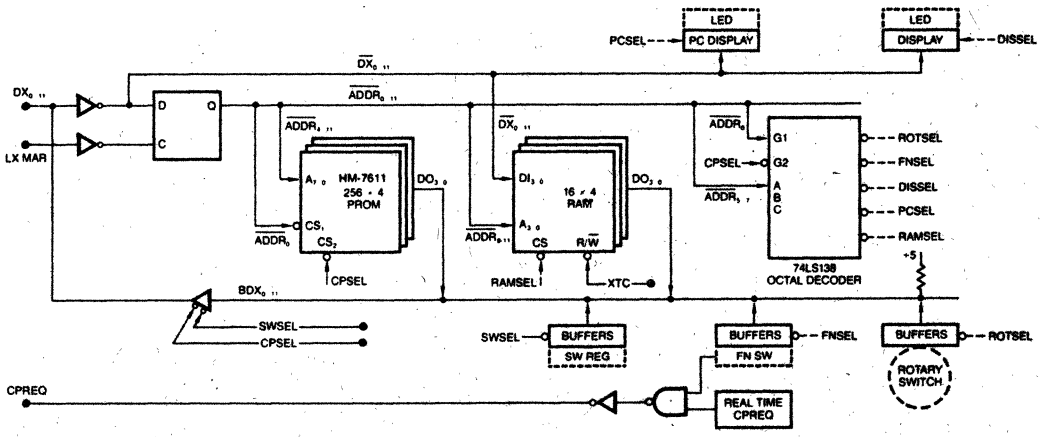
FIGURE 25



TRANSPARENT CONTROL PANEL

A unique feature of the HM-6100 is the provision for a dedicated completely independent control panel with its own memory separate from the main memory. The concept of a "transparent" control panel is an important one for microprocessors since microprocessor based production systems normally do not have a full fledged panel and the system designer would like to use the entire capacity of the main memory for the specific system applications. A number of panel options which can greatly increase the usefulness, flexibility and reliability of the system, such as test, maintenance and diagnostic routines, bootstrap loaders, etc., can be incorporated just by increasing the size of the panel memory to handle more software. The panel can be considered as a portable device which can be plugged into a socket on the CPU board, whenever the panel functions are needed, and disconnected, when not needed, without disturbing any part of the user program. (Figure 26.)

FIGURE 26



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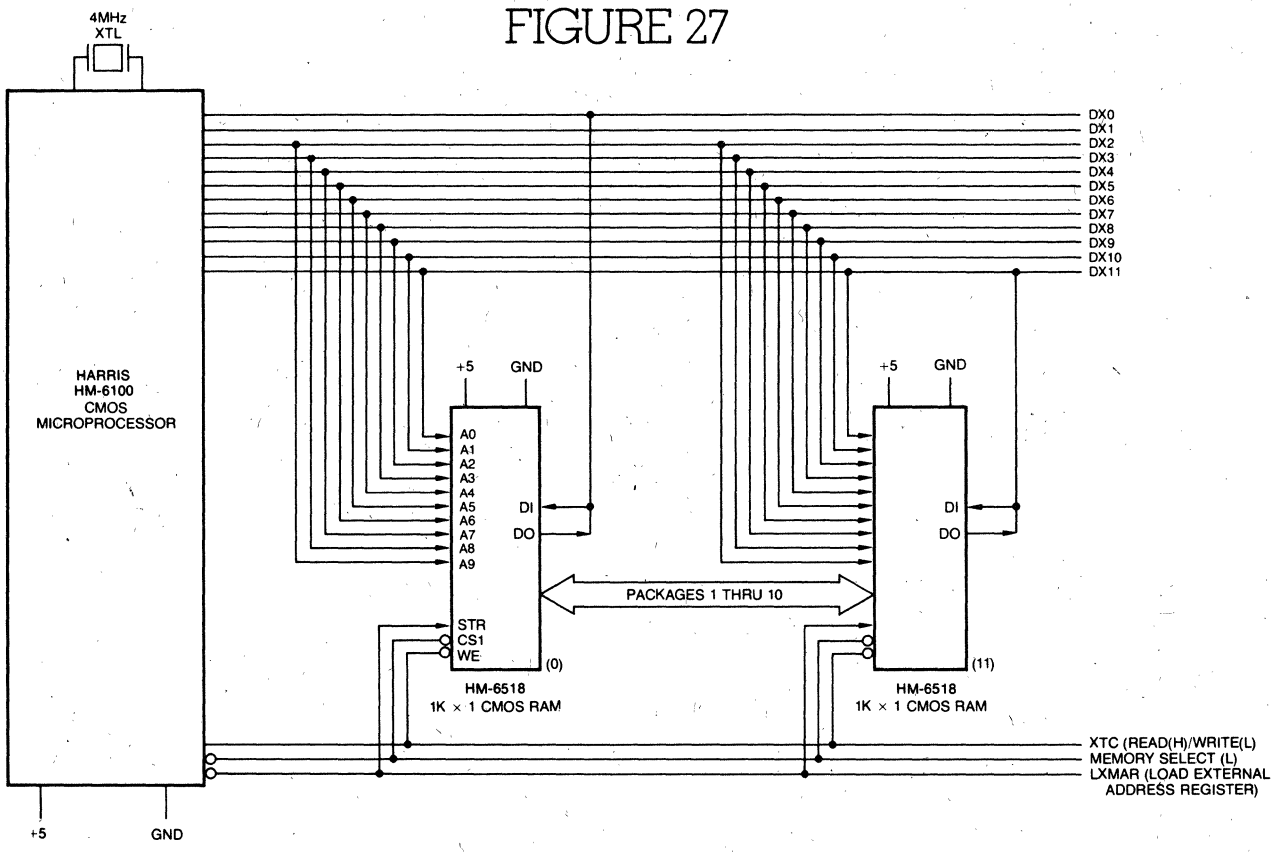
HM-6100 TO CMOS RAM INTERFACE

The HM-6100 provides all the control signals to interface directly with standard CMOS RAM's. Since the CMOS RAM's have internal address latches, the address information on the DX lines is latched internally with the address strobe. Address, Data-in and Data-out can be multiplexed on the DX lines without any degradation in performance. (Figure 27.)

FIGURE 27



Harris reserves the right to make changes in the information contained herein at any time without notice to the user. Information contained herein bearing on specific or potential applications is presented solely for general guidance. Harris assumes no responsibility for user's specific designs or applications, or for infringement of property rights of others in such designs or applications.

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INTRODUCTION

SIMON PROTOTYPING SYSTEM

SIMON provides you an easy economical means of prototyping user systems and evaluating the HM-6100 family of devices in typical configurations. SIMON packaged for bench or desk top operation, is dimensioned 10-3/4" x 16-1/2" x 2-7/8" and precisely duplicates the functions and timing of the HM-6100 microprocessor. The simplified bus structure, being three-state TTL compatible and fully buffered, eases I/O handling and memory operation. The basic PDP-8/E* papertape software supplied by Digital Equipment Corporation will operate properly with SIMON without any software or hardware modifications. The design features of the prototyping system give the user complete flexibility in developing both software and hardware.

Standard PDP-8 programs require the HM-6100 microprocessor to have a Control Panel, 6900-CONTRL, 4K words of RAM, 6901-M4KX12, and a PDP-8/E compatible Teletype interface, 6902-CPUTTY - the basic modules provided in SIMON. Four 72 pin-36 position edge connectors are provided on a common bus (Figure A). The basic modules utilize three connectors and the fourth is provided as a user option. Access to the bus is available under the unit (Figure B) for user options or for attaching 6904-INTBUS, the Universal Bus. Two Amplimite High Density 20 ①, 25 position pin and socket connectors are provided, uncommitted, at the back of the case, as well as a 9 position connector for teletype interface (Figure C). A 5 volt, 3 amp power supply is provided permitting 1.0 amps for user option modules.

With SIMON, the user has a fully interactive facility to generate and test user programs and peripheral interfaces before commiting to a masked ROM pattern and a final hardware configuration.

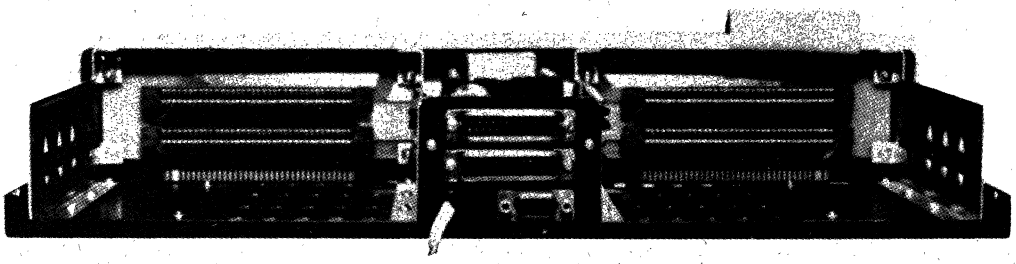

Figure A

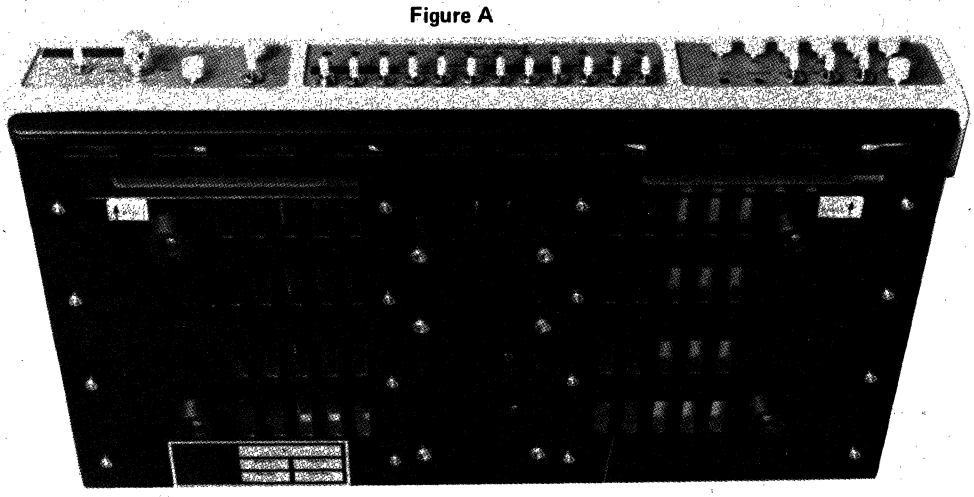

Figure B

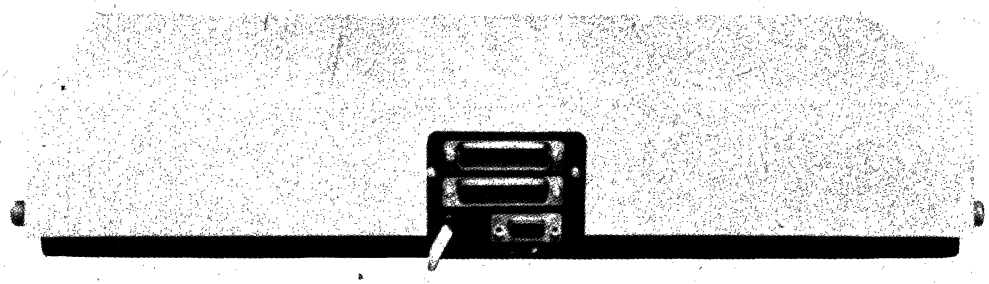

Figure C

*Trademark Digital Equipment Corp.

① AMP INC., Harrisburg, PA

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6900-CONTRL
Control Panel Modules

The 6900-CONTRL consists of all the component parts of SIMON except 6901-M4KX12 and 6902-CPUTTY. 6900-CONTRL is organized in two modules: The first, 6903-CONTRL-1, is a PC board which contains logic and memory and is inserted into the 6900 bus. The second, 6903-CONTRL-2, consists of the case and front panel of SIMON, which contains an array of switches and indicators to facilitate processor operation and maintenance. The logic and memory card, 6903-CONTRL-1, is connected to the control panel module, 6903-CONTRL-2, with a flat cable. The control panel module requires 900 mA at 5 V DC.

The operator may start and stop program execution, examine and modify the contents of the main memory, modify and display internal processor operation, manually load and execute machine language programs or **bootstrap** and execute programs via the Teletype or a high speed tape reader. Since the microprocessor register and internal control signals are not available externally, the modification and display of internal processor information must be done under program control. The console program resides in the console memory which is organized as 16 x 12 RAM-256 x 12 PROM. The console operations are completely **transparent** to the user.

Provisions are made for single instruction and single clock processor operation. The processor state information can also be displayed in **real time.** The user defined routines are implemented with the "USER FN" switch.

Additional information on the 6900-CONTRL module provided in Applications Note HM006 entitled "HM-6100 Operator Console."

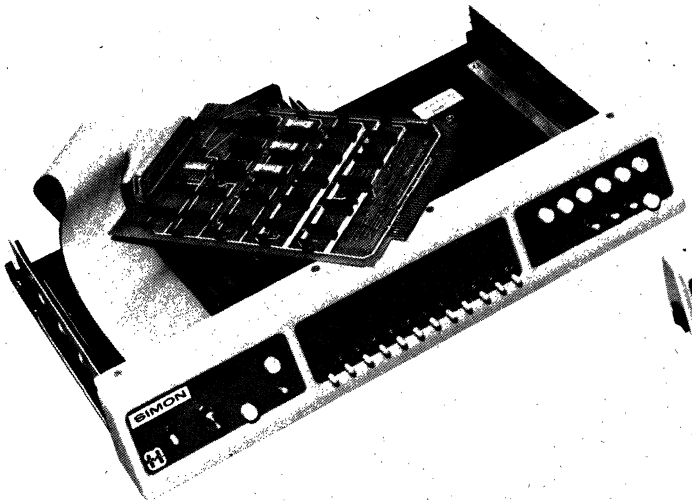

Figure D

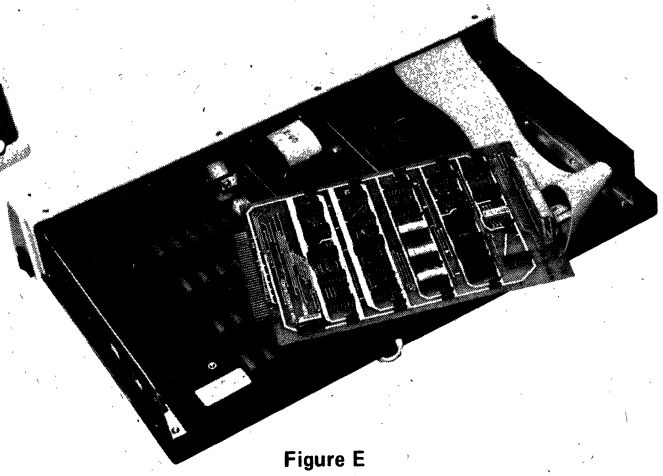

Figure E

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6901-M4KX12 4096 x 12 Nonvolatile CMOS Memory Module

The 4096 x 12 nonvolatile CMOS memory module consists of 48 CMOS static RAMs (HM-6508), providing the user with 49152 bits of random access memory. The module provides for memory expansion by utilizing the Field Select input and is fully decoded and buffered for TTL compatibility. The 3K Write Protect provision enables the user to block the upper 3K words of memory as "read-only" to simulate RAM-ROM configurations. The entire memory may be write protected. The 500mAH Nickel Cadmium battery back-up guarantees data retention up to 40 days and is automatically recharged when the module is powered. If the battery voltage falls below the level required to guarantee data retention, even momentarily, an LED indicator illuminates when the module power is restored. A switch is provided to protect the memory module from stray signals when inserting or removing it from a "live" system. The module requires 400mA at 5 V DC and is dimensioned 6" x 8-½" x ¾".

Additional information on the 6901-M4KX12 module is provided in Applications Note HM004 entitled "Static Memory Systems For the HM-6100". A blank printed circuit board can be ordered by specifying the number 6901.

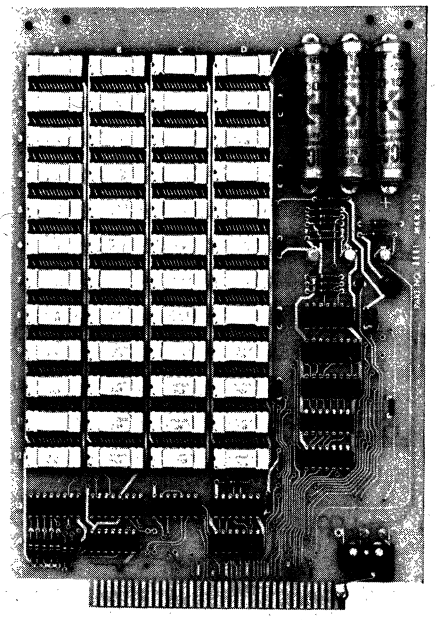

Figure F

6902-CPUTTY HM-6100/Teletype① Module

The 6902-CPUTTY module forms the nucleus of the three-state bus-organized prototyping system. The module contains the HM-6100 microprocessor with a DEC② PDP-8/E compatible parallel Teletype interface. The microprocessor signals are buffered with standard high current three-state buffers and transceivers to define a TTL compatible bus.

All HM-6100 signals are available externally. The input control signals have pull-up resistors to permit open collector wire-ANDing of the request lines. The memory signals are three-stated when the HM-6100 grants a Direct Memory Access request permitting the peripheral device, which requested the DMA, to access memory using the same bus lines as the processor.

Since the 6902-CPUTTY module will be principally used for prototyping, provisions are made to stop the free running crystal controlled oscillator and to introduce a TTL compatible clock externally. Gating is provided to ensure integral clocking.

The module contains the required logic to transfer data between the HM-6100 and an ASR-3320-3JC Teletype keyboard and printer/punch. A Universal Asynchronous Receiver/Transmitter, UART, is provided for parallel-serial data formatting. In view of the fact that the interface is PDP-8/E compatible, DEC PDP-8 software will operate properly without any modification. The serial data formatting is RS-232 compatible and the interface provides for 20mA current loops. The module requires 700mA at 5 V DC and is dimensioned 6" x 8-½" x ¾".

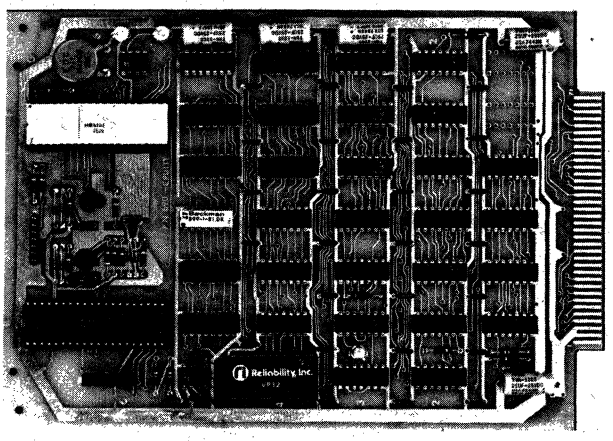

Figure G

Additional information on the 6902-CPUTTY module is provided in Applications Note HM005 entitled "Teletype Interface for the HM-6100 CMOS Microprocessor". A blank printed circuit board can be ordered by specifying the number 6902.

①Trademark – Teletype Corporation
②Trademark – Digital Equipment Corporation, Maynard, MA

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SOFTWARE AND HARDWARE OPTIONS

The following additional hardware modules and software packages are also available from Harris Semiconductor.

6904-INTBUS Universal Bus

The 6904-INTBUS shown in Figure H has a bus structure as defined in Appendix 1. The panel provides for eight 72 Pin-36 Position connectors with 1-1/4" connector to connector spacing. A 3' x 2" Flat Flexible Cable is provided to permit attaching the 6904-INTBUS to SIMON for user expansion. The power supply for the 6904-INTBUS is user supplied.

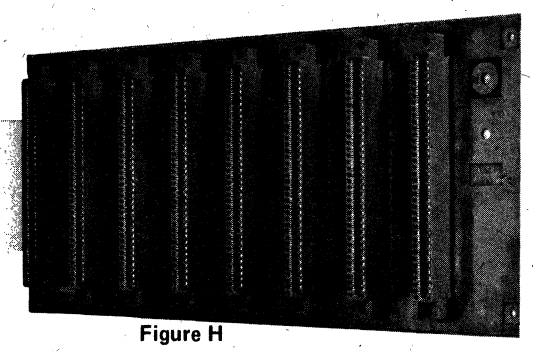

Figure H

6905-WIREWP Universal Wirewrap Module

The Universal Wirewrap module shown in Figure I permits the user to prototype and incorporate user interfaces to the 6900 system. The module provides for all standard dual in line pin spacings.

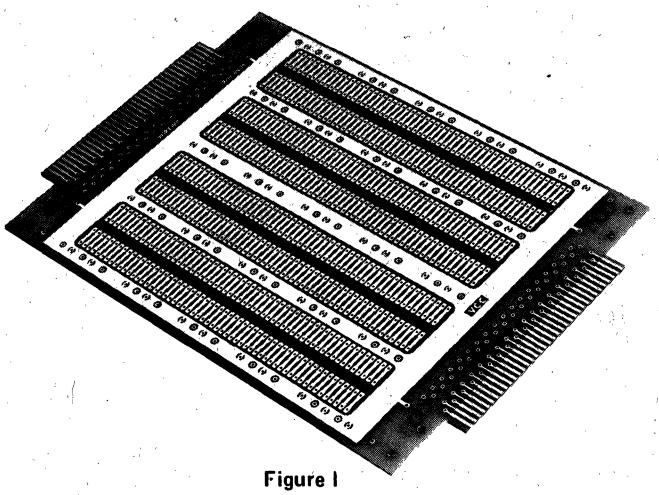

Figure I

6906-EXTEND Extender Module

The Extender module shown in Figure J enables the user to extend and 6900 card for servicing, testing, trouble-shooting and debugging.

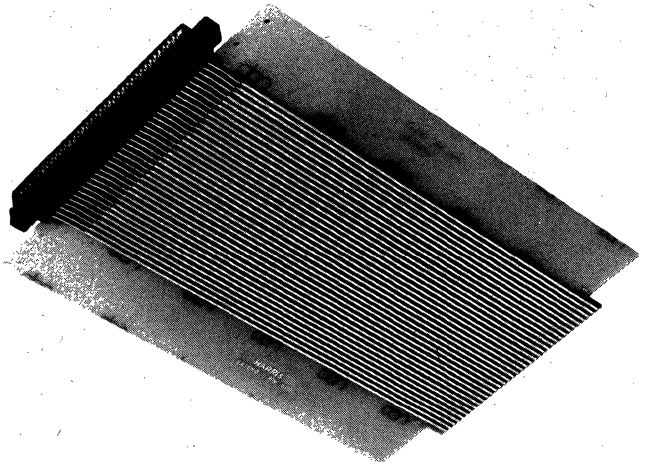

Figure J

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Extended Software Package (QF081-AB)

The basic PDP-8/E papertape software kit assists the user in creating and editing programs and in debugging and correcting programs after assembly or compilation. Additional information on the software is provided in the Applications Bulletin HM003 entitled "HM-6100 CMOS Microprocessor Basic Software".

PDP-8/E EXTENDED SOFTWARE KIT

DOCUMENTATION

Small computer handbook (8E, 8F, 8M)
PDP-8 pocket reference card
Introduction to programming
PDP-8 family commonly used utility routines
4K assemblers PAL III/MACRO-8
Self-starting binary loader (PDP-8E, 8M, 8F only)

BINARY PAPERTAPES

Self-starting binary loader
PAL III
DDT*
ODT (LOW)
ODT (HIGH)
Symbolic editor
RIM punch ASR 33 high memory
OCTAL memory dump
Binary punch ASR 33
PDP-8 23 BIT floating point package
RIM papertapes
Binary loader

Diagnostic Software Kit (ZF002-RB)

This software package consists of programs to perform extensive tests on the processor, memory and the Teletype. The Prototyping System will execute the complete set of processor, memory and Teletype diagnostics for the PDP-8/E.

FOCAL-8* (IS-LFOCA)

FOCAL-8 is an interactive algebraic language. FOCAL's desk calculator mode of operation makes the full computational power of the processor available to the user in response to simple sentence structured keyboard commands. FOCAL is similar to BASIC, ALGOL and FORTRAN in many respects. However, it is more easily learned. The dynamic combination of computational capability and simplicity makes FOCAL-8 an ideal language for on-line problem solving without having to master a complex programming language. FOCAL requires only 4K words of RAM and a Teletype. Yet, it offers a full range of mathematical functions, extendable I/O and versatile self-editing capabilities.

FOCAL-8

Document
Binary Papertape
Listing

FOCAL-8 remove/replace

Binary papertape
Listing

FOCAL-8 8K overlay (8/E)

Binary papertape
Listing

FOPAL-III PAL-III FORTRAN Cross Assembler

FOPAL-III is a cross assembler written in standard FORTRAN. The cross assembler is functionally indentical to the PDP-8/E PAL-III Assembler, supplied with the Extended Software Package. It will run on any computer installation that supports FORTRAN.

*Trademark Digital Equipment Corp.

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HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

Preliminary

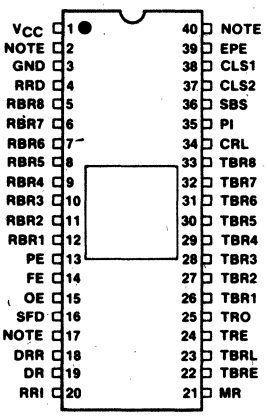
HD-6402/6403
HD-6402A/6403A

CMOS/LSI Universal Asynchronous Receiver (UART)

FEATURES

- OPERATION FROM D.C. TO 3.2MHz
- LOW POWER – TYP. 10mW @ 3.2MHz
- 4V–11V OPERATION
- PROGRAMMABLE WORD LENGTH, STOP BITS AND PARITY
- AUTOMATIC DATA FORMATTING AND STATUS GENERATION
- COMPATIBLE WITH INDUSTRY STANDARD UART's
- CRYSTAL OPERATION–HD-6403

CONNECTION DIAGRAM



NOTE:

PIN	HD-6402	HD-6403
2	N/C	CONTROL
17	RRC	OSC IN
40	TRC	OSC OUT

ORDERING INFORMATION

HD 1 - 6402 A - 2

- HD: HARRIS
- 1: PACKAGE CODE
- 6402: DEVICE NUMBER
- A: VERSION:
  - A: 10.0V Nominal
  - BLANK: 5.0V Nominal
- 2: TEMPERATURE:
  - 2: -55°C to +125°C
  - 9: -40°C to +85°C

DESCRIPTION

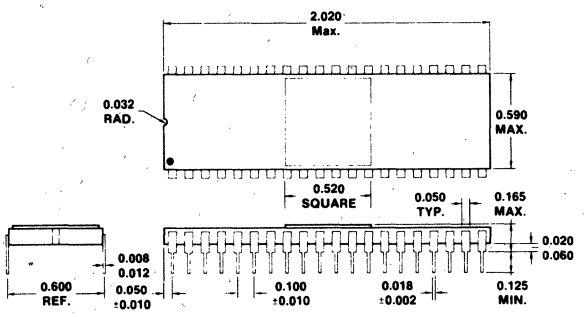
The HD-6402 and HD-6403 are CMOS/LSI subsystems for interfacing computers or microprocessors to an asynchronous serial data channel. The receiver converts serial start, data, parity and stop bits to parallel data verifying proper code transmission, parity, and stop bits. The transmitter converts parallel data into serial form and automatically adds start, parity, and stop bits. The data word length can be 5, 6, 7 or 8 bits. Parity may be odd or even. Parity checking and generation can be inhibited. The stop bits may be one or two or one and one-half when transmitting 5 bit code.

The HD-6402 and HD-6403 can be used in a wide range of applications including modems, printers, peripherals and remote data aquisition systems. CMOS/LSI technology permits operating clock frequencies up to 3.2 MHz (200K Baud) an improvement of 10 to 1 over previous PMOS UART designs. Power requirements, by comparison, are reduced from 300mW to 10mW. Status logic increases flexibility and simplifies the user interface.

The HD-6402 differs from the HD-6403 on pins 2, 17, 19, 22, and 40 as shown in the connection diagram. The HD-6403 utilizes pin 2 as a control and pins 17 and 40 for an inexpensive crystal oscillator as shown on page 5. TBR Empty and DReady are always active. All other input and output functions of the HD-6402 and HD-6403 are as described.

PACKAGE

40 PIN D.I.P.



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ABSOLUTE MAXIMUM RATINGS

Supply Voltage	+12.0V
Input or Output Voltage Applied	GND -.05V to V_{CC} +0.5V
Storage Temperature Range	-65°C to 150°C
Operating Temperature Range	
Industrial HD-6402A-9/6403A-9	-40°C to +85°C
Military HD-6402A-2/6403A-2	-55°C to +125°C

D.C. ELECTRICAL CHARACTERISTICS V_{CC} = 4V to 11V, T_A = Industrial or Military

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	CONDITIONS
Logical "1" Input Voltage	V_{IH}	70% V_{CC}			V	
Logical "0" Input Voltage	V_{IL}			20% V_{CC}	V	
Input Leakage	I_{IL}	-1.0		1.0	μA	$0V \leq V_{IN} \leq V_{CC}$
Logical "1" Output Voltage	V_{OH}	V_{CC} -0.01			V	$I_{OUT} = 0$
Logical "0" Output Voltage	V_{OL}			GND +0.01	V	$I_{OUT} = 0$
Output Leakage	I_O	-1.0		1.0	μA	$0V$ V_O V_{CC}
Supply Current HD-6402A/03A	I_{CC}		5.0	500	μA	$V_{IN} = V_{CC}$
Input Capacitance	C_{IN}		7.0	8.0	pF	
Output Clearance	C_O		6.0	10.0	pF	

A.C. ELECTRICAL CHARACTERISTICS V_{CC} = 10.0V, C_L = 50pF, T_A = 25°C

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	CONDITIONS
Clock Frequency	f_{clock}	D.C.	4.0		MHz	
Pulse Widths CRL, DRR, TBRL	t_{pw}		100		ns	
Pulse Width MR	t_{pw}		250		ns	See Switching Time
Input Data Setup Time	t_{SET}		50		ns	Waveforms 1, 2, 3
Input Data Hold Time	t_{HOLD}		50		ns	
Output Propagation Delays	t_{pd}		100		ns	

SWITCHING WAVEFORMS

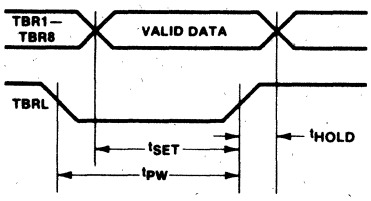

Figure 1.
DATA INPUT CYCLE

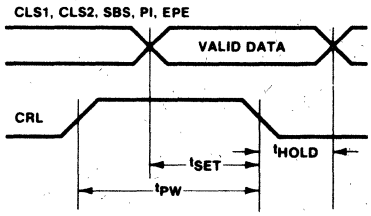

Figure 2.
CONTROL REGISTER LOAD CYCLE

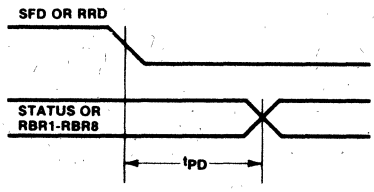

Figure 3.
STATUS FLAG OUTPUT DELAYS OR DATA OUTPUT DELAYS

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ABSOLUTE MAXIMUM RATINGS

Supply Voltage	+8.0V
Input or Output Voltage Applied	GND -0.3V to V_{CC} +0.3V
Storage Temperature Range	-65°C to +150°C
Operating Temperature Range	
Industrial HD-6402-9/6403-9	-40°C to +85°C
Military HD-6402-2/6403-2	-55°C to +125°C

D.C. ELECTRICAL CHARACTERISTICS

V_{CC} = 5.0V ±10%. T_A = Operating Temperature Range.

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	CONDITIONS
Logical "1" Input Voltage	V_{IH}	V_{CC} -2.0			V	
Logical "0" Input Voltage	V_{IL}			0.8	V	
Input Leakage	I_{IL}	-1.0		1.0	μA	$0V \leq V_{IN} \leq V_{CC}$
Logical "1" Output Voltage	$V_{OH}2$	V_{CC} -0.01			V	I_{OUT} = 0
Logical "1" Output Voltage	$V_{OH}1$	2.4			V	I_{OH} = -0.2mA
Logical "0" Output Voltage	$V_{OL}2$			GND +0.01	V	I_{OUT} = 0
Logical "0" Output Voltage	$V_{OL}1$			0.45	V	I_{OL} = 2.0mA
Output Leakage	I_O	-1.0		1.0	μA	$0V \leq V_O \leq V_{CC}$
Supply Current	I_{CC}		1.0	100	μA	V_{IN} = GND or V_{CC}; Output Open
Input Capacitance	C_{IN}		7.0	8.0		
Output Capacitance	C_O		8.0	10.0	pF	

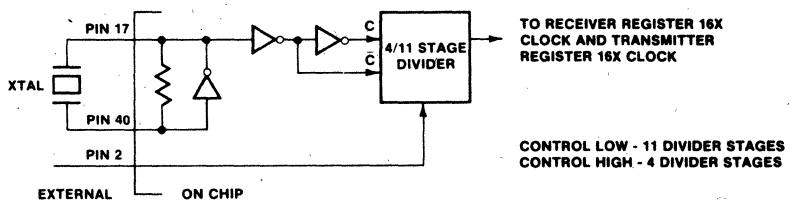
A.C. ELECTRICAL CHARACTERISTICS

V_{CC} = 5.0V, T_A = 25°C

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	CONDITIONS
Clock Frequency	f_{clock}	D.C.	2.0		MHz	
Pulse Widths CRL, DRR, TBRL	t_{pw}		200		ns	
Pulse Width MR	t_{pw}		500		ns	See Switching Time
Input Data Setup Time	t_{SET}		100		ns	Waveforms 1, 2, 3
Input Data Hold Time	t_{HOLD}		100		ns	
Output Propagation Delays	t_{pd}		200		ns	

HD-6403 UNIVERSAL ASYNCHRONOUS RECEIVER TRANSMITTER WITH ON CHIP 4/11 STAGE DIVIDER

The HD-6403 differs from the HD-6402 on three inputs, TRC, RRC, and pin 2, and two outputs TBRE and DR. Outputs DR and TBRE are not three-state, but are always active.



The divider chain output acts as a 16X clock to both the receiver register and transimitter register. Consequently both receiver and transmitter operate at the same frequency. The TRClock and RRClock inputs are used for a crystal oscillator while pin 2 controls the number of divider stages.

The on chip divider and oscillator allow an inexpensive crystal to be used as a timing source rather than additional circuitry such as baud rate generators. For example, a color TV crystal at 3.579545MHz results in a baud rate of 109.2Hz for an easy teletype interface.

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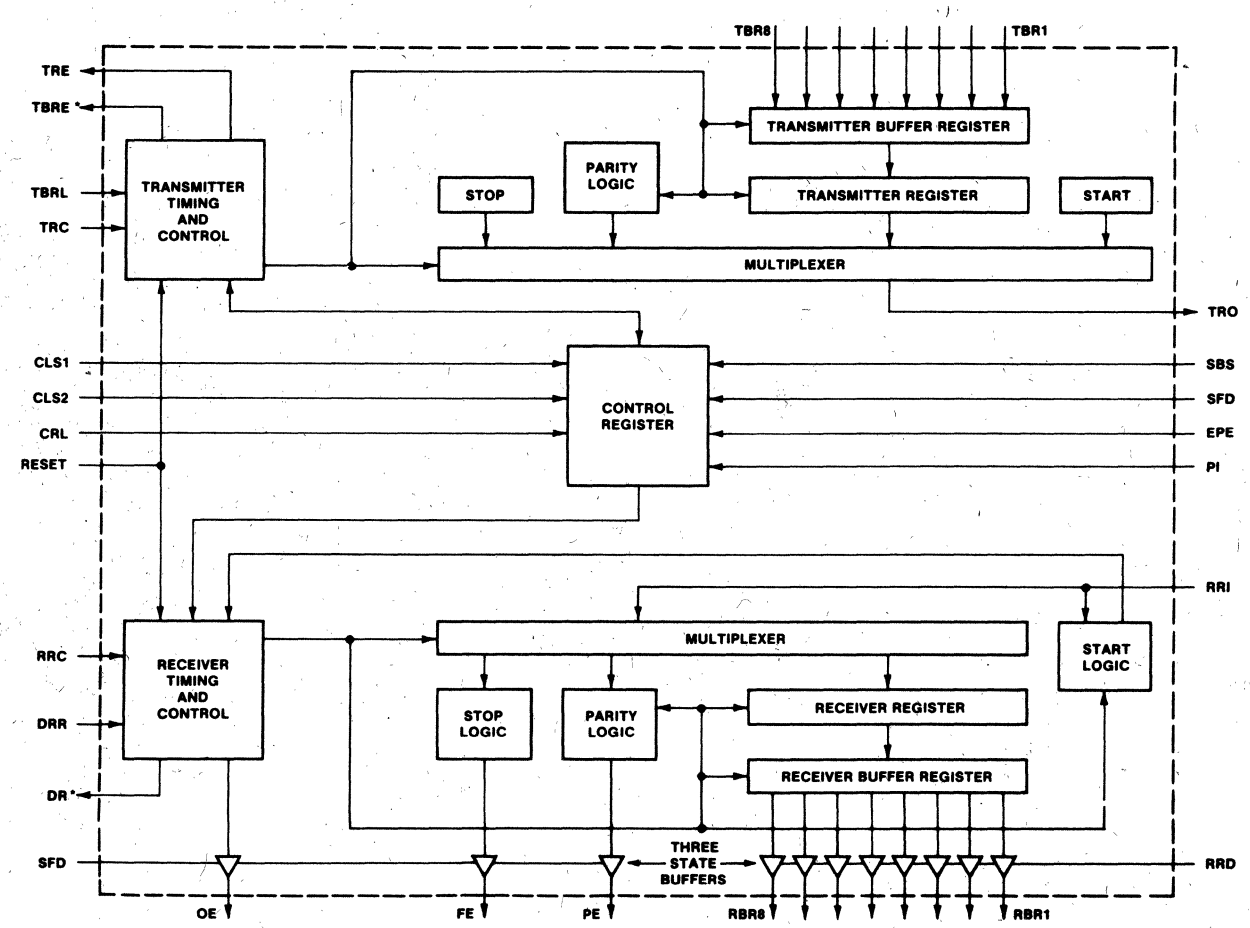
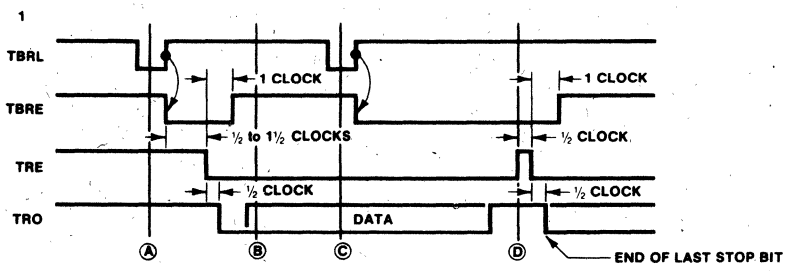
FUNCTIONAL BLOCK DIAGRAM



* These outputs are three state (HD-6402) or always active (HD-6403).

TRANSMITTER OPERATION

The transmitter section accepts parallel data, formats it and transmits it in serial form on the TROutput terminal. (A) Data is loaded into the transmitter buffer register from the inputs TR1 through TR8 by a logic low on the TBRLoad input. Valid data must be present at least t_{SET} prior to and t_{HOLD} following the rising edge of TBRL. If words less than 8 bits are used, only the least significant bits are used. The character is right justified into the least significant bit, TR1. (B) The rising edge of TBRL clears TBREmpty. ½ to 1½ clock cycles later data is transferred to the transmitter register and TREmpty in cleared. ½ cycle later transmission starts. Output data is clocked by TRClock. The clock rate is 16 times the data rate. ½ clock cycle later TBREmpty is reset to a logic high. (C) A second pulse on TBRLoad loads data into the transmitter buffer register. Data transfer to the transmitter register is delayed until transmission of the current character is complete. (D) Data is automatically transferred to the transmitter register and transmission of that character begins one clock cycle later.



TRANSMITTER TIMING (NOT TO SCALE)

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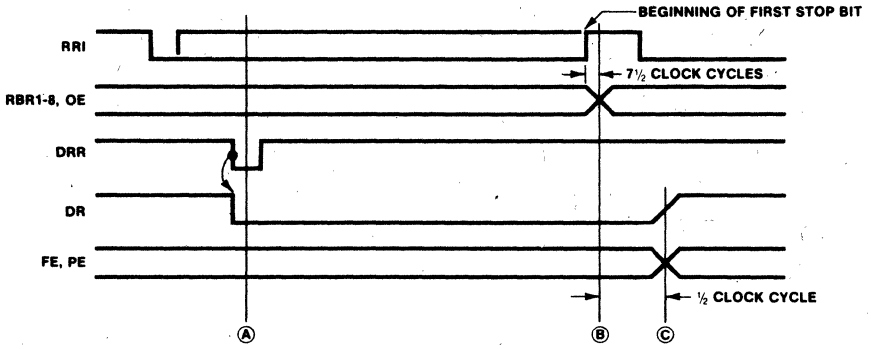
RECEIVER OPERATION

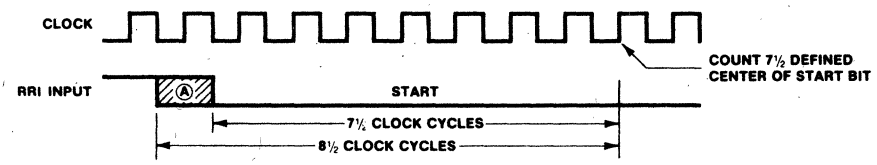
Data is received in serial form at the RInput. When no data is being received, RInput must remain high. The data is clocked through the RRClock. The clock rate is 16 times the data rate. (A) A low level on DRReset clears the DReady line. (B) During the first stop bit data is transferred from the receiver register to the RBRegister. If the word is less than 8 bits, the unused most significant bits will be a logic low. The output character is right justified to the least significant bit RBR1. A logic high on OError indicates overruns. An overrun occurs when DReady has not been cleared before the present character was transferred to the RBRegister. (C) ½ clock cycle later DReady is reset to a logic high, PError and FError are evaluated. A logic high on FError indicates an invalid stop bit was received, a framing error. A logic high on PError indicates a parity error.



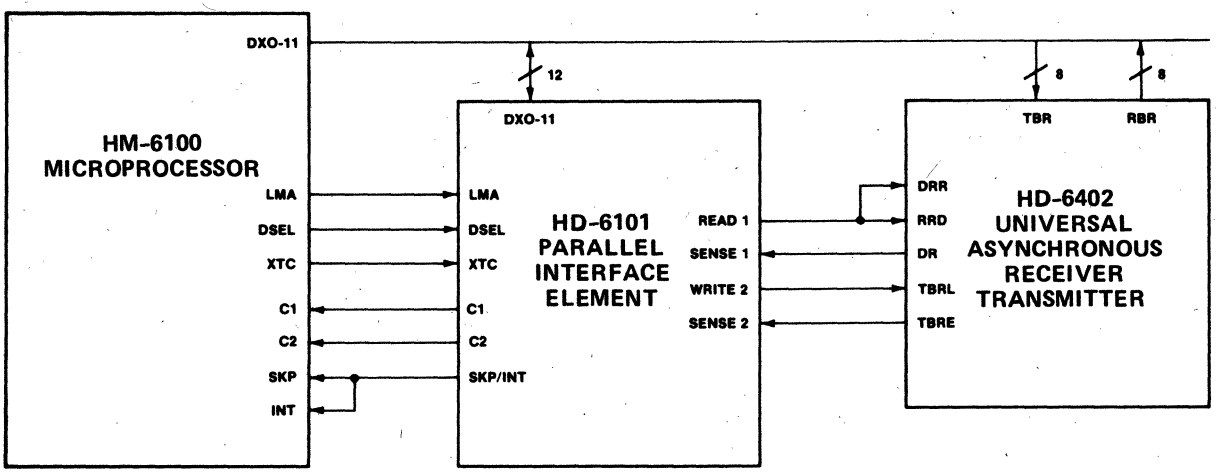
RECEIVER TIMING (NOT TO SCALE)

START BIT DETECTION

The receiver uses a 16X clock for timing. (A) The start bit could have occurred as much as one clock cycle before it was detected, as indicated by the shaded portion. The center of the start bit is defined as clock count 7½. If the receiver clock is a symetrical square wave, the center of the start bit will be located within ±½ clock cycle, ±1/32 bit or 3.125% giving a receiver margin of 46.875%. The receiver begins searching for the next start bit at the center of the first stop bit.



INTERFACING WITH THE HM-6100 MICROPROCESSOR



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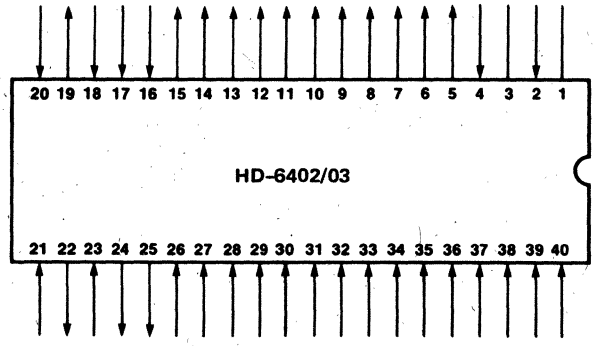
PIN ASSIGNMENT AND FUNCTIONS

PIN	SYMBOL	DESCRIPTION
1	VCC	+5 Volts Supply
2	HD-6402-N/C HD-6403-Control	No Connection 4/11 Stage Divider High: 4 Stage Low: 11 Stage
3	GND	Ground
4	RRD	A High level on RECEIVER REGISTER DISABLE forces the receiver holding register outputs RBR1-RBR8 to a high impedance state.
5	RBR8	The contents of the RECEIVER BUFFER REGISTER appear on these three-state outputs. Word formats less than 8 characters are right justified to RBR1.
6	RBR7	See Pin 5 - RBR8
7	RBR6	See Pin 5 - RBR8
8	RBR5	See Pin 5 - RBR8
9	RBR4	See Pin 5 - RBR8
10	RBR3	See Pin 5 - RBR8
11	RBR2	See Pin 5 - RBR8
12	RBR1	See Pin 5 - RBR8

PIN	SYMBOL	DESCRIPTION
13	PE	A high level on PARITY ERROR indicates received parity does not match parity programmed by control bits. When parity is inhibited this output is low.
14	FE	A high level on FRAMING ERROR indicates the first stop bit was invalid.
15	OE	A high level on OVERRUN ERROR indicates the data received flag was not cleared before the last character was transferred to the receiver buffer register.
16	SFD	A high level on STATUS FLAGS DISABLE forces the outputs PE, FE, OE, DR, TBRE to a high impedance state.
17	HD-6402-RRC HD-6403-OSCIN	The RECEIVER REGISTER CLOCK is 16X the receiver data rate.
18	DRR	A low level on DATA RECEIVED RESET clears the data received outputDR, to a low level.
19	DR	A high level on DATA RECEIVED indicates a character has been received and transferred to the receiver buffer register.
20	RRI	Serial data on RECEIVER REGISTER INPUT is clocked into the receiver register.



PIN	SYMBOL	DESCRIPTION
21	MR	A high level on MASTER RESET clears PE, FE, OE, and DR to a low level and sets the transmitter output to a high level.
22	TBRE	A high level on TRANSMITTER BUFFER REGISTER EMPTY indicates the transmitter buffer register has transferred its data to the transmitter register and is ready for new data.
23	TBRL	A low level on TRANSMITTER BUFFER REGISTER LOAD transfers data from inputs TBR1-TBR8 into the transmitter buffer register. A low to high transition on TBRL indicates data transfer to the transmitter register. If the transmitter register is busy, transfer is automatically delayed so that the two characters are transmitted end to end.
24	TRE 6	A high level on TRANSMITTER REGISTER EMPTY indicates completed transmission of a character including stop bits.
25	TRO	Character data, start data and stop bits appear serially at the TRANSMITTER REGISTER OUTPUT.
26	TBR1-TBR8	Character data is loaded into the TRANSMITTER BUFFER REGISTER via inputs TBR1-TBR8. For character formats less than 8 bits the TBR8, 7, and 6 inputs are ignored corresponding to the programmed word length.

PIN	SYMBOL	DESCRIPTION
27	TBR2	See Pin 26 - TBR1
28	TBR3	See Pin 26 - TBR1
29	TBR4	See Pin 26 - TBR1
30	TBR5	See Pin 26 - TBR1
31	TBR6	See Pin 26 - TBR1
32	TBR7	See Pin 26 - TBR1
33	TBR8	See Pin 26 - TBR1
34	CRL	A high level on CONTROL REGISTER LOAD loads the control register.
35	PI	A high level on PARITY INHIBIT inhibits parity generation, parity checking and forces PE output low.
36	SBS	A high level on STOP BIT SELECT selects 1.5 stop bits for 5 character format and 2 stop bits for other lengths.
37	CLS2	These inputs program the CHARACTER LENGTH SELECTED. (CLS1 low CLS2 low 5 bits) (CLS1 high CLS2 low 6 bits) (CLS1 low CLS2 high 7 bits) (CLS1 high CLS2 high 8 bits)
38	CLS1	See Pin 37 - CLS2
39	EPE	When PI is low a high level on EVEN PARITY ENABLE generates and checks even parity. A low level selects odd parity.
40	HD-6402-TRC HD-6403-OSCOUT	The TRANSMITTER REGISTER CLOCK is 16X the transmit data rate.

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HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

PRELIMINARY

HD-6101/6101A

CMOS PARALLEL INTERFACE ELEMENT

FEATURES

- HM-6100 COMPATIBLE
- LOW POWER – TYP.<5.0μW STANDBY
- 4 – 11 VOLT SUPPLIES
- HIGH SPEED
- STATIC OPERATION

INSTRUCTIONS

1000 – READ2	0000 – READ1
1001 – WRITE 2	0001 – WRITE1
1010 – SKIP3	0010 – SKIP 1
1011 – SKIP4	0011 – SKIP2
1100 – WVR	0100 – RCRA
1101 – WCRB	0101 – WCRA
1110 – SFLAG3	0110 – SFLAG1
1111 – CFLAG3	0111 – CFLAG1

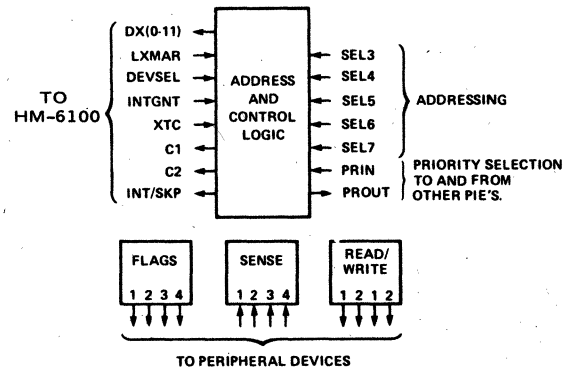
6007 – CAF (Internal IOT) clears interrupt requests

DESCRIPTION

The HD-6101 and HD-6101A Parallel Interface Elements (PIE) are high speed, low power, silicon gate CMOS general purpose devices which provide addressing, interrupt and control for a variety of peripheral functions, such as UARTs, FIFOs, Keyboards, etc. The PIE is designed to eliminate external logic. Data transfers between the HM-6100 CMOS Microprocessor and the HD-6101 are via IOT instructions, control lines and DX bus.

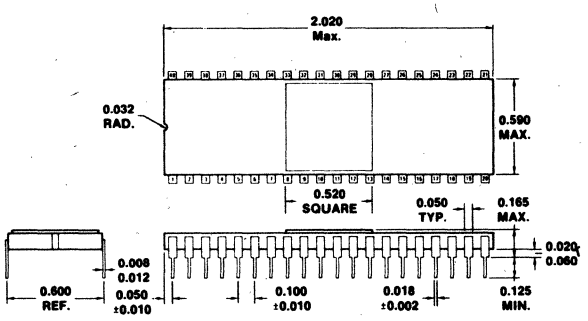
Data transfers between peripheral devices and the DX bus are controlled by the PIE via 2 read, 2 write, 4 sense and 4 flag functions. The A and B registers program write polarities, sense polarities, sense levels or edges, flag values and interrupt enables. The vector register has 10 bits writeable from the HM-6100 and 2 bits indicating the highest priority SENSE input that generated the interrupt.

FUNCTIONAL DIAGRAM

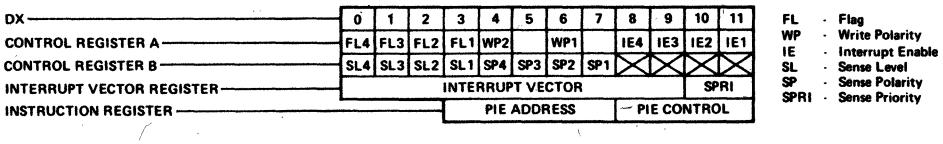


PACKAGE

40 LEAD D. I. P. PACKAGE



REGISTER BIT ASSIGNMENTS



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SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Supply Voltage		Operating Temperature Range	
HD-6101	+8.0V	Industrial (-9)	-40°C to 85°C
HD-6101A	+12.0V	Military (-2)	-50°C to 125°C
Applied Input or Output Voltage	GND-0.3V to V_{CC} +0.3V	Operating Voltage Range	
Storage Temperature Range	-65°C to 150°C	HD-6101	4V to 7V
		HD-6101A	4V to 11V

D. C. CHARACTERISTICS V_{CC} = Operating Voltage Range T_A = Temperature Range

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Logical "1" Input Voltage	V_{IH}	70% V_{CC}			V	
Logical "0" Input Voltage	V_{IL}			20% V_{CC}	V	
Input Leakage	I_{IL}	-1.0		1.0	μA	$0V \leq V_{IN} \leq V_{CC}$
Logical "1" Output Voltage	V_{OH2}	V_{CC} - 0.01			V	$I_{OUT} = 0$
Logical "1" Output Voltage	V_{OH1}	2.4			V	$I_{OH} = -0.2$ mA
Logical "0" Output Voltage	V_{OL2}			GND + 0.01	V	$I_{OUT} = 0$
Logical "0" Output Voltage	V_{OL1}			0.45	V	$I_{OL} = 2.0$ mA
Output Leakage	I_O	-1.0		1.0	μA	$0V \leq V_O \leq V_{CC}$
Supply Current	I_{CC1}		1.0		μA	$V_{IN} = V_{CC}$
	I_{CC2}		1.0		mA	$V_{CC} = 5V$ $f_{HM-6100} = 4MHz$
Input Capacitance *	C_I		5	7	pF	
Output Capacitance *	C_O		8	10	pF	
Input/Output Capacitance *	C_{IO}		8	10	pF	

* Guaranteed and sampled, but not 100% tested.

A. C. CHARACTERISTICS $T_A = 25°C$ $C_L = 50$ pF

PARAMETER		SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Delay From DEVSEL To READ	(6101)	t_{DR}		150		ns	$V_{CC} = 5.0V$
	(6101A)			75		ns	$V_{CC} = 10.0V$
Delay From DEVSEL To WRITE	(6101)	t_{DW}		150		ns	$V_{CC} = 5.0V$
	(6101A)			75		ns	$V_{CC} = 10.0V$
Delay From DEVSEL To FLAG	(6101)	t_{DF}		200		ns	$V_{CC} = 5.0V$
	(6101A)			100		ns	$V_{CC} = 10.0V$
Delay From DEVSEL To C1, C2	(6101)	t_{DC}		200		ns	$V_{CC} = 5.0V$
	(6101A)			100		ns	$V_{CC} = 10.0V$
Delay From DEVSEL To SKP/INT	(6101)	t_{DI}		200		ns	$V_{CC} = 5.0V$
	(6101A)			100		ns	$V_{CC} = 10.0V$
Delay From DEVSEL To DX	(6101)	t_{DA}		200		ns	$V_{CC} = 5.0V$
	(6101A)			100		ns	$V_{CC} = 10.0V$
LXMAR Pulse Width	(6101)	t_{LXMAR}		200		ns	$V_{CC} = 5.0V$
	(6101A)			100		ns	$V_{CC} = 10.0V$
Address Set-Up Time	(6101)	t_{ADDS}		50		ns	$V_{CC} = 5.0V$
	(6101A)			25		ns	$V_{CC} = 10.0V$
Address Hold Time	(6101)	t_{ADDH}		100		ns	$V_{CC} = 5.0V$
	(6101A)			50		ns	$V_{CC} = 10.0V$
Data Set-Up Time	(6101)	t_{DS}		200		ns	$V_{CC} = 5.0V$
	(6101A)			100		ns	$V_{CC} = 10.0V$
Data Hold Time	(6101)	t_{DH}		50		ns	$V_{CC} = 5.0V$
	(6101A)			25		ns	$V_{CC} = 10.0V$

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APPLICATION

The HM-6100, Parallel Interface Element (PIE), provides a universal means of interfacing industry standard LSI devices and peripheral equipment controllers to the HM-6100 Microprocessor.

The HM-6100 configures each PIE for a specific interface during system initialization by programming the control registers within the PIE for write enable polarities, sense polarities, sense edges or levels, flag values and interrupt enables.

The data transfer between the HM-6100 and the peripheral devices does not take place through the PIE. The Parallel Interface Element provides the steering signals for data transfers. This approach was chosen since all the standard LSI elements such as Keyboard chips , UARTs, FIFOs, etc. have internal storage latches and they require only control signals to take data from the bus or to put data on the bus. If some user defined peripheral interfaces do not have these built-in storage elements, discrete CMOS or low power Schottky latches, or flip-flops, must be provided to store the data from the HM-6100 until the peripheral device is ready to accept it and the latch data from the peripheral devices until the HM-6100 asks for it.

INTERRUPT HANDLING WITH PIE'S

The PIEs provide for a vectored priority interrupt scheme. Up to 31 PIEs may be chained to obtain 124 interrupt lines. The microprocessor will recognize, identify and start servicing the highest priority interrupt request within 30.5μs at 4 MHz.

The INTREQ lines from all PIEs are wire-ANDed together. A PIE generates an interrupt request, if any one of its four sense lines, which are interrupt enabled, become active by driving the INTREQ line to the HM-6100 low. If no higher priority requests are outstanding (RESET, CPREQ, HLT or DMAREQ), the HM-6100 will grant the request at the end of the current instruction. The content of the Program Counter is deposited in location 0000_8 of the memory and the program fetches the next instruction from location 0001_8. The return address is hence available in location 0000_8. This address must be saved in a software stack if nested interrupts are allowed.

The HM-6100 activates the INTGNT signal high when an INTREQ is acknowledged. The INTGNT is reset by executing any IOT instruction. The PIEs use the INTGNT signal to freeze the priority network and to uniquely specify the PIE with the highest priority interrupt request. The PIE with the highest priority request sends a unique vector address to the HM-6100 when the processor executes the first IOT instruction after the INTGNT. It is recommended that the internal processor instruction, Interrupt Off (IOF - 6002_8) be used for vectoring. IOF, in this context, is a NOP since the interrupt system is automatically disabled after an interrupt grant.

The 12-bit vector address generated by the PIE consists of 10 high order bits from the vector register, defined by the user during system initialization, and two low order bits which indicate the sense input that generated the interrupt. Therefore, if the instruction in location 0001_8 is IOF - 6002_8, the processor will branch to 1 of 4 locations, depending on which of the sense lines within a PIE generated the request. Each one of these locations must contain a Jump instruction pointing to the specific service routine for the corresponding sense input. The 30.5 μs interrupt acknowledge time at 4 MHz consists of 14 μs (max) to recognize an interrupt request, 3 μs to grant an interrupt request, 8.5 μs to execute the IOF for vectoring and 5.0 μs to execute a JUMP instruction to a specific service routine.

PIN INSTRUCTION FORMAT

The HM-6100 communicates with PIEs using the Input-Output Transfer (IOT) instructions. The first three bits, 0-2, are always set to 6_8 (110) to specify an IOT instruc- The standard DEC* convention is to set the next 6 bits, 3-8, to specify 1 of 64 I/O devices and then to control the operation of the selected I/O device by using bits 9-11. However, the DEC interfaces are not standardized since a specific pattern of bits 9-11 could specify completely different operations in different I/O devices. For example, the pattern 000 in bits 9-11 could mean a read operation for Interface A, write operation for Interface B, a skip instruction for Interface C and so on since the operation for any IOT instruction depends entirely upon the circuitry designed into the I/O device interface.

The IOT instruction format for the PIE is different from that used by DEC interfaces. The first three bits are, as usual set to 6_8 to indicate an IOT instruction. The next 5 bits, 3-7, specify 1 of 31 PIEs and then the operation of the selected PIE is controlled by bits 8-11 in 16 uniquely specified ways. For example, the specified pattern 0000 in bits 8-11 means exactly the same operation for all PIEs, namely activate READI line.

Of the 32 possible combinations of bits 3-7, the pattern 00000 is reserved for internal Processor IOT instructions and hence not available as a PIE address. The 6900 Prototyping System assigns bit patterns 00001 and 00010 for the PDP-8E^T compatible Teletype interface and these two addresses also must not be used for PIEs if the 6900 System is used for prototyping.

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ASYNCHRONOUS SERIAL INTERFACE WITH PIE AND UART

The HD-6402/03 Universal Asynchronous Receiver/Transmitter is a general, purpose programmable serial device for interfacing an asynchronous serial data channel to a parallel synchronous data channel. The receiver converts a serial word with start, data, parity and stop bits to a parallel data word and checks for parity, framing and data overrun errors. The transmitter section converts a parallel data word into a serial word with a start, data, parity, and stop bits. The data word length may be 5, 6, 7, or 8 bits. Parity may be odd or even. Parity checking and generation can be inhibited. The number of stop bits may be 1 or 2 or 1½ transmitting a 5 bit code.

The HD-6402/03 can be used in a wide variety of applications including interfacing modems, TeletypesT and remote data acquisition systems to the HM-6100 microprocessor. The HD-6403 makes provisions for a crystal oscillator and internal divider chain to specify the data transfer rate. In the HD-6402 the data transfer rate is controlled by an external timing source, for example, a Baud Generator.

A functional block diagram of the PIE/UART/HM-6100 interface is shown on the following page. The UART is configured, in this specific example, to interface with an ASR-33 Teletype which has a data format that consists of 11 bits - a start bit, 8 data bits and 2 stop bits. The UART is clocked at 16X the data rate. For the 10 character per second ASR-33, the UART clock frequency would be 1.76 KHz. The configuration shown is compatible with the DEC BIN and RIM paper tape formatting.

PIE/UART HM-6100 INTERFACE

An 8-bit data word from the HM-6100 Accumulator is loaded into the Transmitter Buffer Register via inputs TBR8-TBR1 when the Transmit Buffer Register Load (TBRL) signal makes a zero to on transition. A high level on Transmit Buffer Register Empty (TBRE) indicates that the buffer is ready to accept a new character for transmission. The microprocessor checks the status of TBRE via SENSE2 before it transmits a new character to the UART by pulsing WRITE1. The start bit, data bits and stop bits appear serially at the Transmit Register Output (TRO).

A serial data stream on the Receiver Register Input (RRI) is clocked onto the Receiver Buffer Register. A high level on Data Received (DR) indicates that a character has been received. The contents of Receiver Buffer Register appear on the outputs RBR8-RBR1 when a low level is applied to Receiver Register Disable (RRD) input. The RBR outputs are tristated when RRD is high. A low level on Data Received Reset (DRR) clears the DR flag. RRD and DRR may be tied together to clear DR as the register data is being read. The microprocessor monitors the status of the DR flag via SENSE1 to see if a new character has been received before it reads the information stored in the buffer register by pulsing READ1 low.

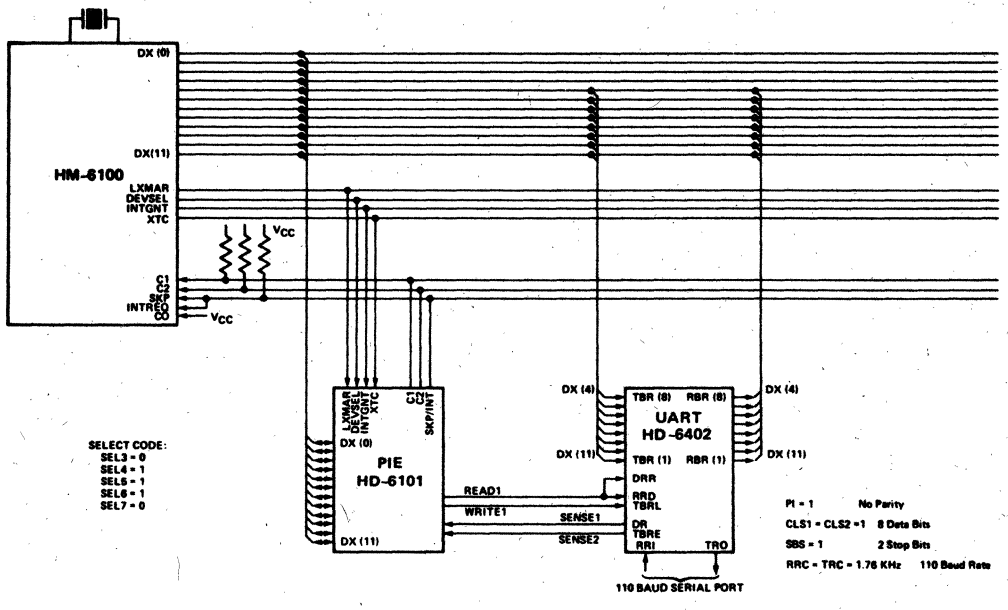
The UART interface uses only the low order 8 bits of the HM-6100 data bus (DX) to receive and transmit characters.

* Digital Equipment Corporation, Maynard, MA

TRegistered Trademark, Digital Equipment Corporation

T Registered trademark for Teletype Corporation

PIE/UART HM-6100 INTERFACE



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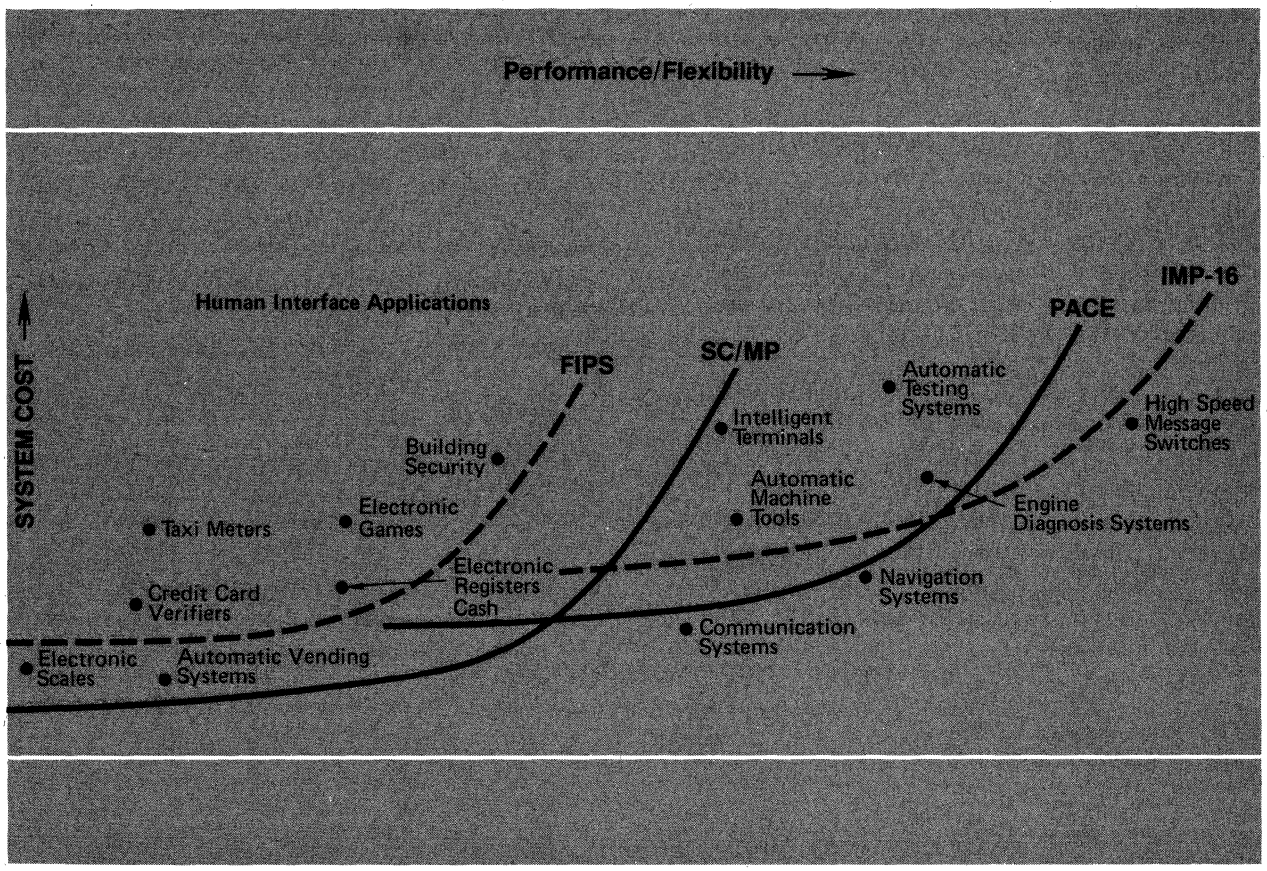
National microprocessors for

Microprocessor Family Spectrum



National is a pioneer in the microprocessor business. Ever since IMP-16, our aim has been to develop simple, economical alternatives to random logic for the engineer who builds control systems.

This brochure will show you what we've done since 1972: the product families, development tools, and field user support that have made National microprocessors the control elements of choice for an ever growing number of engineers and logic designers.

High Technology Solutions to Control Problems

Microprocessor technology is more than "gee whiz" processes. National microprocessors incorporate advanced thinking in high technology architectures. It is our belief that innovations such as true minicomputer instruction sets, powerful addressing modes, and sophisticated internal structures; supported by high-yielding technologies, ultimately offer the simplest, lowest cost control solutions.

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control, computation, communications

The Family Concept

The microprocessor application spectrum is incredibly diverse; and a variety of microprocessors must be available if the user is not to compromise speed for price, performance for compactness, etc. Thus we make a range of microprocessor products, to provide you with devices that are:

- **Cost effective at every level of application**
- **Readily available**
- **Fully supported with hardware, software and prototyping tools**
- **Simple to design with**
- **The fastest route to a working system**

SC/MP

SC/MP is the newest and simplest National microprocessor. It is the lowest-cost replacement available for electrical, mechanical and hydraulic control systems. Typical applications include games, business machines, scales, cash registers and other human interface devices.

PACE

At the opposite end of the spectrum, PACE is a full 16-BIT "mini-computer on a chip". Its wide word length, hardware-vectored interrupt structure, and sophisticated addressing modes make it ideal for laboratory instrumentation, data acquisition and process control applications, where number handling and fast response are most important.

IMP-16

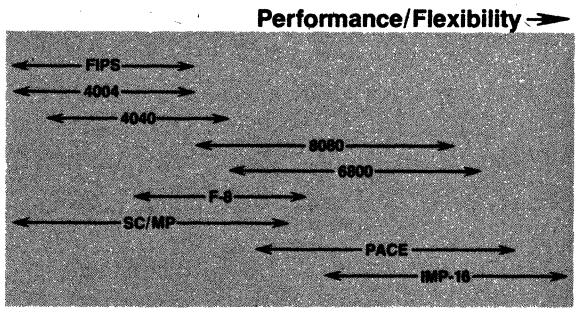
IMP-16, big brother to PACE, is the most versatile of the 16-bit processors. Offering the user an expandible, bit-slice architecture, microprogrammability, and a variety of instruction sets; IMP-16 is uniquely suited to complex control, analysis, and data reduction tasks.

FIPS

FIPS is National's second source to the MCS-4 family.* This was the first production microprocessor system, and it is still quite popular because of its simplicity and low cost.

Covering the spectrum of Microprocessor Applications

National's microprocessor family was designed to cover a large section of the microprocessor applications spectrum. New products coming out in the following months will help to fill in the spectrum by building upon PACE and SC/MP to produce upward- and downward-compatible families of processors to meet any application need.



*MCS-4 is a registered trademark of Intel Corp.

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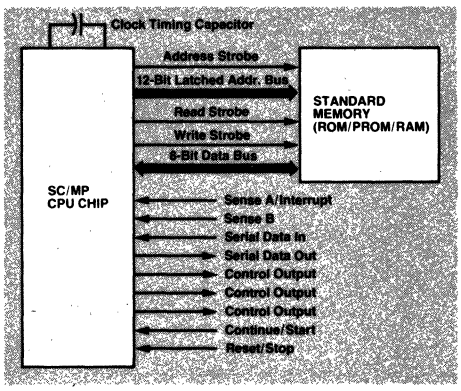
SC/MP
The lowest-cost microprocessor

Replacing Springs, Gears and Levers

SC/MP replaces simple electrical and mechanical control systems in applications where simplicity of design, low parts count, and low system cost are very important. SC/MP applies the accuracy and simplicity of digital control to a whole new range of applications: scales, automatic locks, intelligent handheld instruments; and a variety of other applications where electronic solutions were never considered before.

- **Low parts count for low cost**
- **On-chip clock simplifies system design**
- **Built-in serial I/O port for easy interfacing**
- **Built-in flags and jump conditions simplify control tasks**
- **Interrupt structure gives fast response to asynchronous events**
- **Control-oriented instruction set uses memory efficiently**
- **Delay instruction simplifies timer systems**

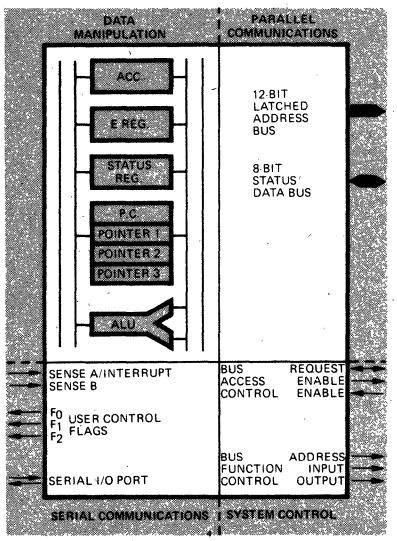


Simple Economics

SC/MP offers great economic advantages over more traditional control elements. Its programmable logic allows it to handle a variety of sequencing operations, without the need for complex cams, gears, and timing elements. Built-in serial I/O lets it take measurements, make decisions, and then transmit data directly to other processors without the need for UART's in between. SC/MP's low cost allows it to be used as a peripheral to other microprocessors, giving users the advantages of volume and standardization.

Human Interface Devices

In human interface devices, SC/MP also offers real advantage. Its built-in control flags and jump conditions simplify keyboard scanning directly from the microprocessor chip. Thus credit card verifiers, small instruments, intelligent scales and electronic cash registers can be designed compactly, at low cost.



Instruments

SC/MP's built-in binary and BCD arithmetic capability allow it to do number crunching. It can detect control settings and set up instrument circuits; and can also receive data, evaluate it, format it, and retransmit it to other systems.

Timers

SC/MP's unique DELAY function allows a designer to quickly build multi-station timers and sequencers. Process controllers, lawn sprinkler timers, and a variety of other timer applications become simple with SC/MP.

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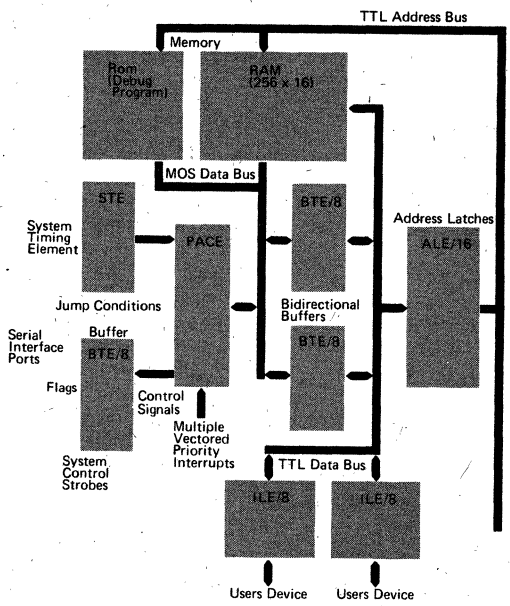
PACE
The easy-to-use control microprocessor

PACE was built to be the easiest-to-design with, easiest-to-use microprocessor available. And it is!

- **Multiple accumulators make number crunching easy**
- **Fast response thru multiple, hardware-vectored interrupts**
- **Built-in serial I/O saves external logic**
- **Easy to program**
- **Sophisticated instruction set uses memory efficiently**
- **Low cost**
- **Fully supported with hardware and software**

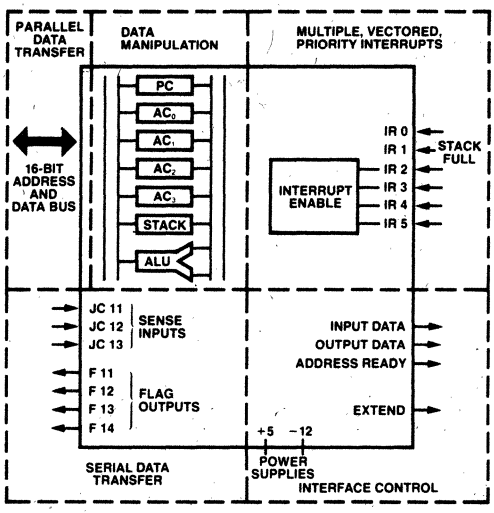


Technology and Smart Architecture

When PACE was introduced in 1975, it pushed the state of the art. It was the first one-chip, 16-bit microprocessor. A descendent of National's IMP-16, it sports the interrupt structure, addressing modes, and logical capabilities that one traditionally associates with minicomputers.

PACE's high technology architecture is the starting point for processing capability and instruction set efficiency PACE users have come to depend upon.

This built-in sophistication makes PACE the simplest, easiest-to-use microprocessor on the market.



PACE for Computation

PACE handles 16-bit data in a single cycle. This makes it ideal for real-world calculations where accuracy must be kept to *a tenth of a percent or better.* When handling large numbers to high accuracy, PACE's 16-bit architecture gives it clear advantages in speed and memory efficiency over 8-bit processors which struggle to handle large numbers.

PACE for Communication

PACE handles both 8- and 16-bit data. Thus it can handle the most complex character and error-correcting codes. It allows the user his choice of data word length, while retaining the efficiency of wide instruction words and single cycle instruction fetches.

PACE for Control

Logical and bit testing instructions make PACE ideal for control applications where it is necessary to sense and control a large number of events. Multi-level, built-in, hardware-vectored interrupts give fast response to real-world control situations.

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IMP-16
The original 16-bit microprocessor

16-Bit Economics

IMP-16 was built to handle traditional "minicomputer" applications, where the cost of a mini couldn't be justified. Its 16-bit architecture gives high efficiency in handling real-world arithmetic values and bit manipulation. Furthermore, the efficiency of two-byte instructions often allows programs to be smaller than they would be for 8-bit processors.

- **Bit slice approach lets you add power as needed**
- **Multiple instruction sets tailor IMP-16 to your job**
- **Highly flexible bus structure**
- **High speed—1.4 μs cycle time**
- **Handles both serial and parallel I/O directly**
- **Both hardware- and software-vectored interrupts available**
- **Fully documented and supported**

Microprogrammed Flexibility

The IMP-16 is built up from two device types: a 4-bit slice of the processor elements (RALU), and a Control ROM (CROM) that contains microcode to define the instruction set. Because CROMs can be tailored to suit different classes of applications, you can build up an IMP-16 to give the highest performance and efficiency in each application. And if we haven't built the CROM you need, you can design your own, using our Microprogram Development System.

But we give you quite a choice. Starting with CROM I, which holds a basic instruction set for the processor, you can add any of the following instruction sets.

CROM II (Extended Instruction Set)

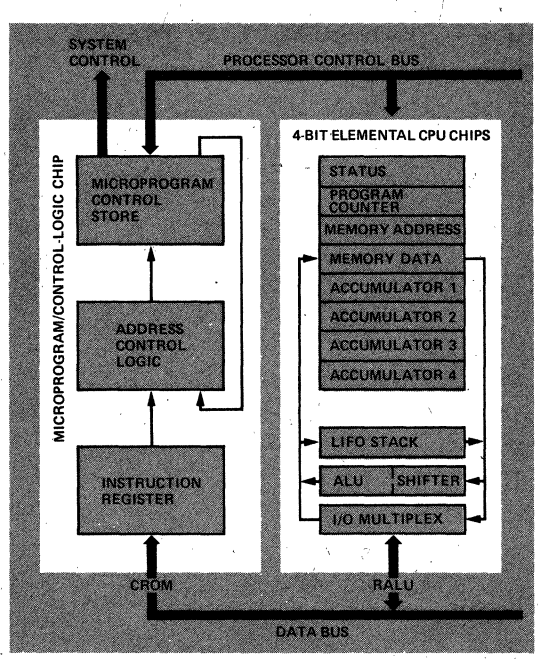
CROM II extends the basic instruction set to include MULTIPLY, DIVIDE, BIT SET/TEST, and other general purpose instructions.

POWR I/O

This CROM facilitates high-speed data movement and string processing with instructions like: BLOCK TRANSFER, MEMORY SEARCH, and STACK SAVE/RESTORE.

MATH CROM

MATH CROM simplifies heavy-duty number crunching with DOUBLE PRECISION ADD/SUB/MUL/DIV and other arithmetic instructions.



Advantages of IMP-16

IMP-16 has proved most popular in control and data manipulation applications that can take advantage of its 16-bit word length. It offers economies to the designer who needs a variety of instruction sets to handle different applications, but who would like to learn only one architecture.

IMP-16 is supported by one of the most comprehensive hardware/software development packages available, and is completely documented for ease of use.

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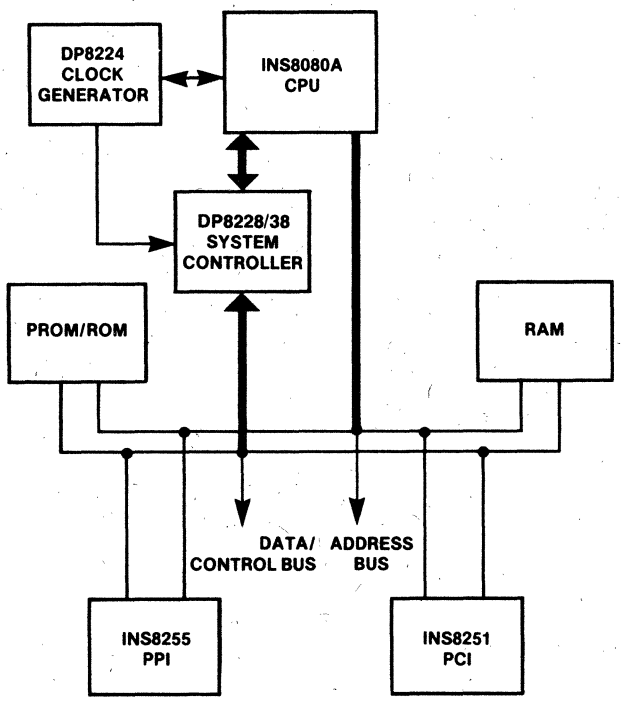
N8080 Family Rounding out National's Microprocessor Capability

Covering the broad general purpose segment of microprocessor applications is the National 8080 family. Providing the 8080A as well as proprietary designs, this 8-bit microcomputer system is equally at home in designs ranging from complex controls to highly sophisticated communications applications.

Benefits

- **Family approach to system design**
- **Complete CPU group**
- **Programmable I/O concepts**
- **Multiple source availability**
- **Complete line of support components**
- **Total product support**



The INS8080A

Positioned between the cost-effective SC/MP and the highly versatile PACE for 16-bit applications, the INS8080A can be used in systems which range from a few family components to designs which utilize its full capabilities.

Supporting the INS8080A

National puts its Schottky bipolar technology to work providing the clocks for the CPU and the system with the DP8224, while data bus buffering and System Control is provided by the DP8228. Further interfacing of bus and control lines can be implemented using National's wide variety of Linear and Digital interface components.

System Flexibility

Using the N8080 family, the designer can satisfy system requirements from the wide range of National's RAM, PROM, ROM and I/O components. Programmable I/O and peripheral functions allow the designer the freedom to configure and adapt interface lines to his own requirements. For program storage, the flexible PROM is matched by direct replacement ROMS. For random access storage the designer can choose from one of the industry's broadest lines of RAMS; encompassing bipolar, MOS, and CMOS technologies.

N8080 Development Support

From experimentation to final production, National hardware and software support is designed to provide the full range of development tools. Look to the N8080 for basic design kits, easy to implement development systems, and a full complement of cross and resident assemblers.

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N8080 Family

Part No.	Description	Availability
INS8080A	8-BIT CPU, 2 μSEC CYCLE	NOW
INS8080A-1	8-BIT CPU, 1.3 μS CYCLE	NOW
INS8080A-2	8-BIT CPU, 1.5 μS CYCLE	NOW
DP8224	CLOCK GENERATOR	NOW
DP8228	SYSTEM CONTROLLER	NOW
DP8238	SYSTEM CONTROLLER— ADVANCED TIMING	NOW
DP8212	8-BIT I/O/PORT	NOW
INS8255	PROGRAMMABLE PERIPHERAL INTERFACE	1 QTR. '77
INS8251	PROGRAMMABLE COMMUNICATIONS INTERFACE	2 QTR. '77
DP8216	4-BIT BI-DIRECTIONAL BUS DRIVER	1 QTR. '77
DP8226	4-BIT BI-DIRECTIONAL BUS DRIVER (INV.)	1 QTR. '77

N8080 Support Devices

Part No.	Description	Availability
MM57101	ASYNCHRONOUS COMMUNICATION ELEMENT	2 QTR. '77
74LS138	1 OF 8 BINARY DECODER	NOW
DS8833	BI DIRECTIONAL BUS DRIVER NON-INV.	NOW
DS8835	BI DIRECTIONAL BUS DRIVER INV.	NOW
MM1702A	256 x 8 PROM, ERASABLE	NOW
MM5204Q	512 x 8 PROM, ERASABLE	NOW
MM2708	1K x 8 PROM, ERASABLE	4 QTR. '76
DM87S295,6	512 x 8 PROM	4 QTR. '76
MM5213	256 x 8 ROM	NOW
MM5242	1K x 8 ROM	NOW
MM2316A	2K x 8 ROM	NOW
MM74C920	256 x 4 STATIC CMOS RAM	NOW
MM5269	256 x 4 STATIC RAM (LATCHED INPUT)	NOW
MM2101-2	256 x 4 STATIC RAM, SEPARATE I/O	NOW
MM2111-2	256 x 4 STATIC RAM, COMMON I/O	NOW
MM2102-2	1K x 1 STATIC RAM 650ns	NOW
MM2102A-4	1K x 1 STATIC RAM 450ns	NOW
MM5255,6	1K x 4 STATIC RAM	4 QTR. '76
MM5257	4K x 1 STATIC RAM	4 QTR. '76
MM5280B	4K x 1 DYNAMIC RAM	NOW

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FIPS
The original 4-bit microprocessor

National's 4-Bit Processor

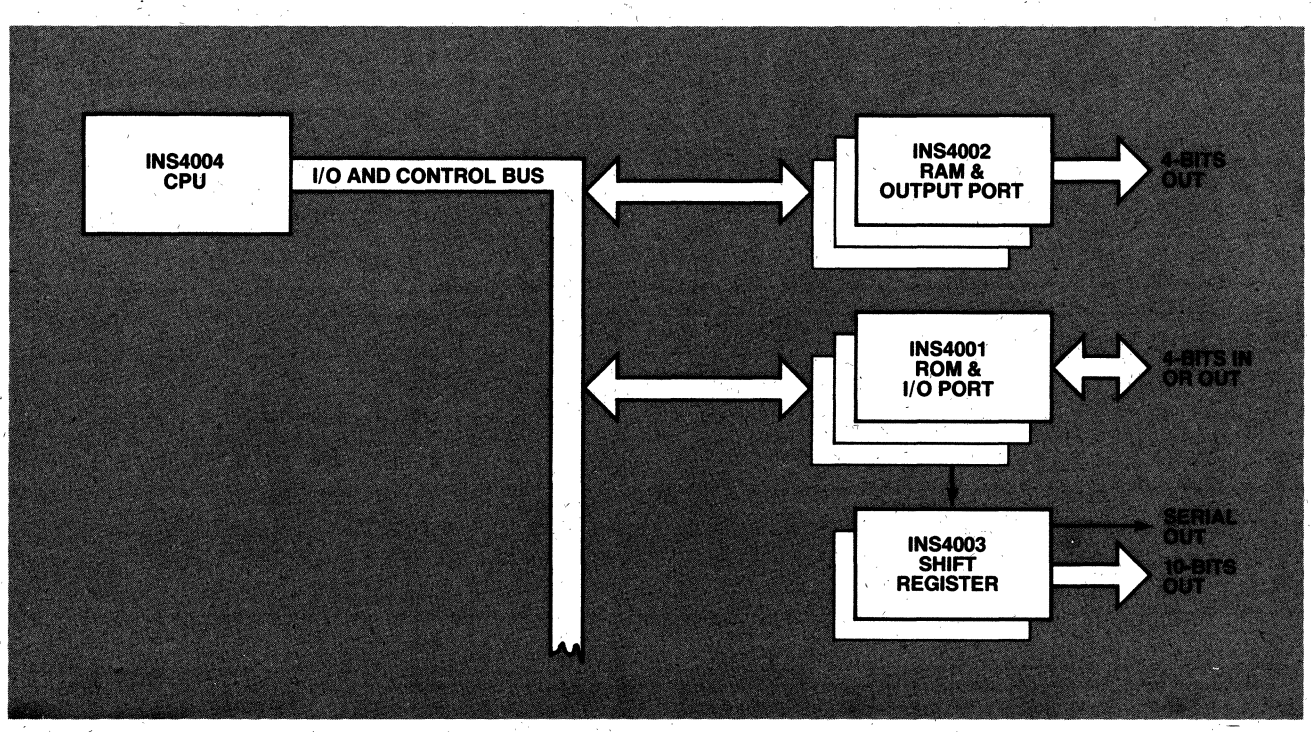
FIPS is National's trade name for it's MCS-4* compatible family. This family is now built by two major semiconductor manufacturers, offering the user the security of multiple sourcing and competitive pricing.

Applications

FIPS has found itself designed into a variety of simple control and human interface applications where sophisticated features are not important. Thus FIPS has become popular for scales, simple keyboard applications, and low speed human interface applications.

- **High volume means low cost**
- **Readily available off the shelf**
- **Widely understood by microprocessor system designers**

National Part #	Equivalent Intel Part	Description	Availability
INS4001	4001	ROM	NOW
INS4002-1	4002-1	RAM	NOW
INS4002-2	4002-2	RAM	NOW
INS4003	4003	SHIFT REGISTER	NOW
INS4004	4004	CPU	NOW
INS4008	4008	ADDRESS LATCH	NOW
INS4009	4009	MULTIPLEXER	NOW
INS4201	4201	CLOCK	2 QTR, '76



*MCS-4 is a registered trademark of Intel Corporation

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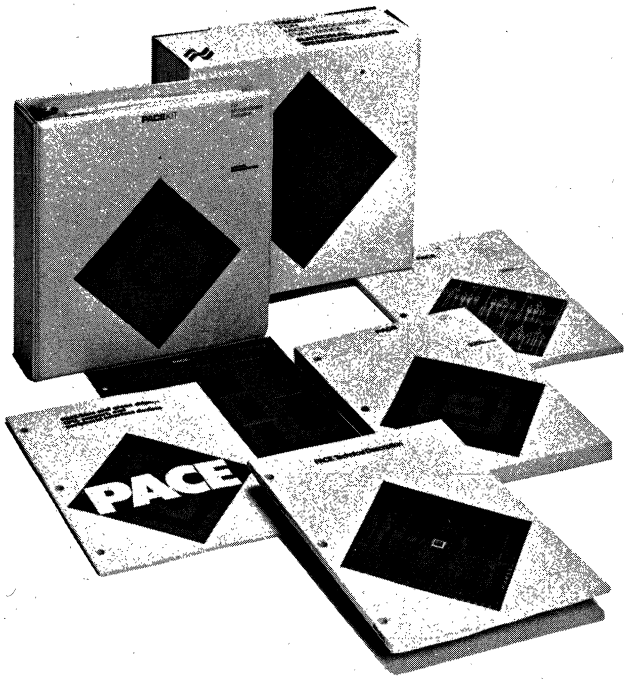
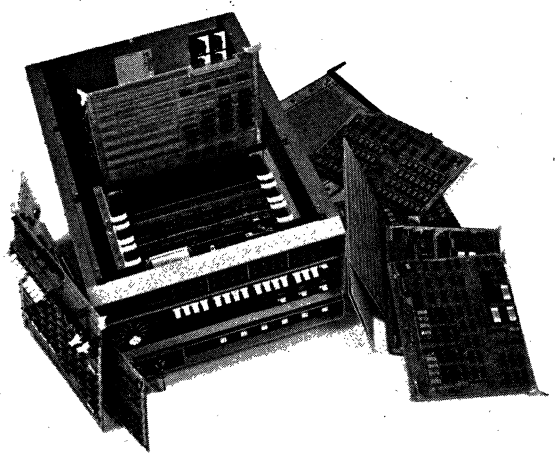
PACEkit—Get Off to a Fast Start

PACEkit is a complete component package; it enables the user to build up and experiment with simple PACE systems; develop and debug small programs, and experiment with advanced interrupt structures.



Prototyping—Hardware Development

The PACE and IMP-16P Development Systems are sophisticated tools that include a CPU, memory, interfaces; the works. They are complete and self-contained. The PACE system has the additional capability of emulating PACE operation in the user's system. Using the Development Systems, an engineer can quickly develop and evaluate PACE and IMP-16 based control systems. And best of all, he can quickly convert an IMP-16 system for PACE and vice-versa; thus cutting capital equipment costs.



Software Development

Strong software support tools reflect in lower system cost, lower engineering cost, and a quicker development cycle.

At National, we take software seriously. That is why we were first with a Conversational Assembler, first with a disc-based development system; and why we have spent a lot of time and money to give you the kinds of tools that speed your software development. Both PACE and IMP-16 are supported with relocating cross- and resident assemblers, conversational assembler/editors, utilities, and diagnostics. There's even a translator to convert IMP-16 programs for PACE.

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design aids

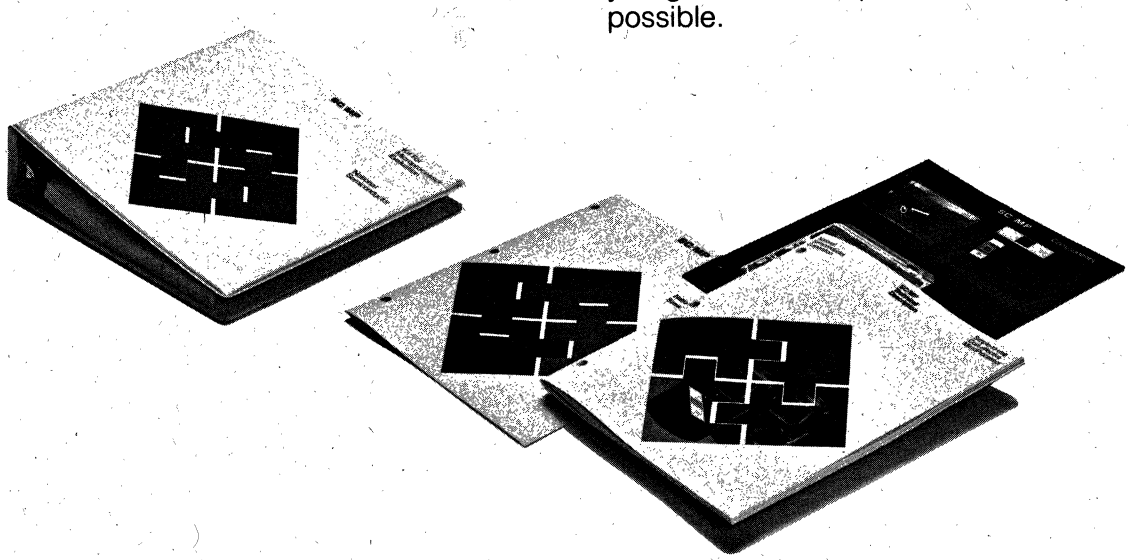
Getting to Know SC/MP— SC/MP Kit

The SC/MP kit is a collection of parts, documentation, and application information to help a designer get off the ground quickly with SC/MP. Inside is everything a user needs to design and build up simple SC/MP systems.

SC/MP Software Support

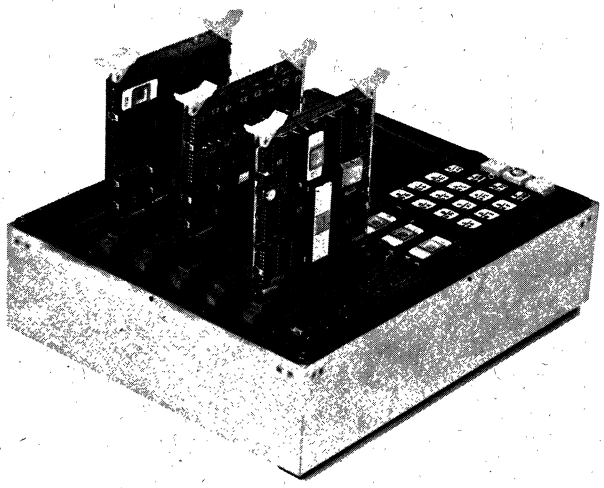
SC/MP is presently supported by cross assemblers written in both FORTRAN and IMP-16 assembly language. A PACE cross assembler is in the works. In addition, SC/MP supports resident debug software and absolute loaders (included in SC/MP LCDS), and hardware diagnostics.

Software support is an on-going concern at National. Our software is designed to help you get ideas into production as quickly as possible.



SC/MP LCDS

LCDS (Low Cost Development System) is a more complete package for the user who needs more power than the SC/MP kit affords. It includes a keyboard, display, memories, microprocessor, and interface circuits that allow a user to rapidly develop and debug small programs, and experiment with interrupts and interface structures.



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Total Product Support

Around the processor are the support devices, documentation, application services, training, and other services that make it possible to use the product. Often, the availability of these devices and services makes the difference between a successful design effort and a complex project that drags on and on.

For this reason, National has given a lot of thought to devices and services that simplify the designer's job, and help to insure his success.

Applications Support

National knows applications support is important. That is why we have invested in a factory microprocessor applications group that's always here to help when you have questions on hardware or software.

Training

National offers a series of graduated courses that let you study with people at your own level. At National, school isn't a spectator sport. Each course includes a full two days of hands-on laboratory training on a development system. Microprocessor courses are presently taught in Santa Clara, California; Dallas, Texas; and Miami, Florida.

User Group

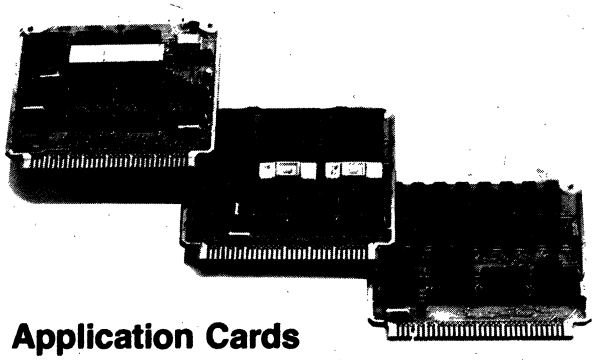
COMPUTE, National's user group, is a software-sharing, idea-sharing organization. Its purpose is to get information to designers about new products, bugs, application ideas, and things that will make them more successful users. It includes a growing library of software programs to help you in your applications.

Field Support

A little advice at the right time can be worth weeks in design. Because National realizes this, it has invested more heavily than any other semiconductor company in field application support. National's trained crew of field application engineers are available to provide you with the latest information on new products and application ideas.

Service

National has built a service center in Santa Clara, CA, to provide timely service for microprocessor products. Fast, efficient repair and retrofit of microprocessor systems is available to any user.



Application Cards

Often the quickest way to get into production is to let someone else do part of the work. To help you get into production quickly, we've done part of your development, with a series of application cards for standard system functions.

Custom Cards

If you want to buy a designed and tested function, instead of just a chip, and our standard cards don't quite meet your needs, give us a call. We have lots of experience designing cards around our processors; and chances are, we can propose a design to meet your needs.

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from National

MICROPROCESSOR SUPPORT DEVICES

	Name	Function	Available
PACE	IPC-16A/502J	System Timing Element	NOW
	IPC-16A/501J	8-Bit Hybrid Bus XCVR	NOW
	BTE	8-Bit Mono. (LS) Bus XCVR	3 QTR, '76
SC/MP	81LS95-98	Tri-State® Octal Buffers	NOW
UNIVERSAL INTERFACE	IPC-16A/518J	16-Bit Hybrid Latch	NOW
	IPC-16A/503J	8-Bit Hybrid Bi-Directional Latch	NOW
	DM8542	Quad I/O Register	NOW
	74C173, 174	4-Bit CMOS Latches	NOW
	DM8546	Tri-State® 8-Bit Universal I/O Shift Reg.	NOW
	LM555, 556	Interval Timer	NOW
	DM74147, 148	Priority Encoder (Interrupt/DMA Control)	NOW
	MM5307	Baud Rate Gen./Prog. Real Time Clock	NOW
	MM5303	UART	NOW
	DS8833	Tri-State® Quad Bus XCVR	NOW
HUMAN INTERFACE	74C922, 3	16 & 20-Key Keyboard Encoders	3 QTR, '76
	MM5740	90-Key Keyboard Encoder	NOW
	DM8544	Tri-State Quad Switch Debouncer	NOW
	DS8859, 69	Hex Latch/Led Driver	NOW
	CD4511BC	7-Segment Latch Decoder Driver	NOW
	DS8692, 3, 4	Seiko Printer Interface Set	NOW
INSTRUMENT & MACHINE INTERFACE	DM8334	8-Bit Bit-Addressable Latch	NOW
	MM5357	8-Bit A-To-D Converter	2 QTR, '76
	AD1210	12-Bit CMOS A-To-D Converter	2 QTR, '76
	DA1200	12-Bit D-To-A Converter	2 QTR, '76
	CD4051C	8-Ch. Analog Mux/Demux	NOW
RAMS	MM5255, 6	1k x 4 Static Ram	3 QTR, '76
	MM5257	4k x 1 Static Ram	3 QTR, '76
	MM2102	1k x 1 Static Ram	NOW
	MM5269	256 x 4 Static Ram	NOW
	MM5270, 80	4k x 1 Dynamic Rams	NOW
	MM74C920	1k x 1 CMOS Static Ram	NOW
ROMS	MM5214	512 x 8 ROM	NOW
	DM8531	2k x 8 Bipolar ROM	NOW
	DM8581	1k x 16 Bipolar ROM	NOW
	MM6242	1k x 8 NMOS ROM	NOW
PROMS	MM5203Q	256 x 8 (512 x 4) Eraseable ROM	NOW
	MM5204Q	512 x 8 Eraseable ROM	NOW
	MM1702A	256 x 8 Eraseable ROM	NOW

NATIONAL—FIRST IN CONTROL MICROPROCESSORS

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ISP-8A/500D single-chip 8-bit microprocessor (SC/MP)

general description

SC/MP (Simple Cost-effective MicroProcessor) is a single-chip 8-bit microprocessor packaged in a standard, 40-pin, dual-in-line package.

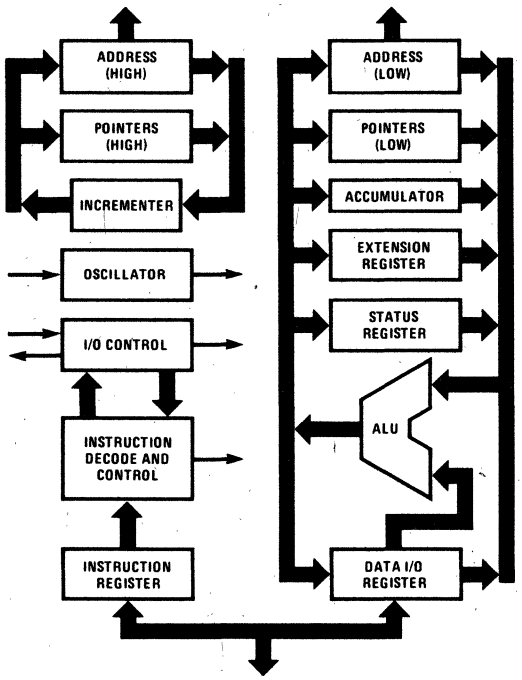
Silicon gate, depletion mode standard-process technology ensures high performance, high reliability, and high producibility.

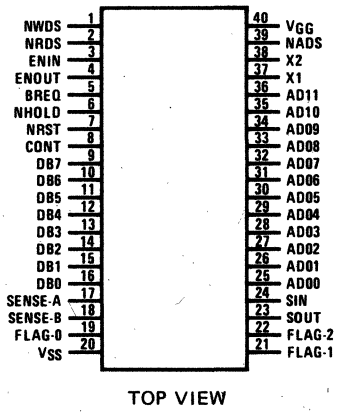
SC/MP is intended for use in general-purpose applications where cost per function is a most significant criterion. But cost efficiency is only a part of SC/MP's story. It goes on to include a variety of useful functions that are not even provided by some of the expensive microprocessors, like self-contained timing circuitry, 16-bit (65k) addressing capability, serial or parallel data-transfer capability and common memory/peripheral instructions. The built-in features in conjunction with the low initial cost describe what SC/MP really is — a microprocessor specifically designed to provide the simplest and most efficient solution to many application requirements.

features

- Simpler interfacing
  - Bidirectional TRI-STATE® 8-bit data bus
  - TTL-compatible input/output interface
- Direct Memory Access (DMA) and multiprocessor capabilities
  - Handshake bus-access control
- Simplified programming
  - Multiple addressing modes — program-counter-relative, immediate data, indexed, auto-indexed, and implied
- Direct control output
  - Three user-accessible control-flag outputs
- Simpler I/O hardware
  - Separate serial-data input and output ports
  - Two sense inputs
  - Direct interfacing to standard memory parts
- On-chip timing
  - Minimizes external hardware required for clock generation
- Interface flexibility
  - Capability to interface with memories or peripherals of any speed
- Large system capability
  - Address capability to 65k bytes of memory
- Simplified power requirements

block and connection diagrams





TOP VIEW

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applications

- Test Systems and Instrumentation
- Machine Tool Control
- Small Business Machines
- Word Processing Systems
- Educational Systems
- Multiprocessor Systems
- Process Controllers
- Terminals
- Traffic Controls
- Laboratory Controllers
- Sophisticated Games
- Automotive

absolute maximum ratings

Voltage at Any Pin	V_{SS} + 0.3V to V_{SS} − 20V
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

electrical characteristics

(T_A = 0°C to +70°C, V_{SS} = +5V ± 5%, V_{GG} = −7V ± 5%)

Parameter	Conditions	Min.	Typ.*	Max.	Units
INPUT SPECIFICATIONS					
ENIN, NHOLD, NRST, SENSE A, SENSE B, SIN, DB0-DB7 (TTL Compatible) (Note 2)					
Logic "1" Input Voltage		V_{SS} − 1		V_{SS} + 0.3	V
Logic "0" Input Voltage		V_{SS} − 10		0.8	V
Pullup Transistor "ON" Resistance (Note 2)	V_{IN} = (V_{SS} − 1)V		7.5	12	kΩ
Logic "0" Input Current	V_{IN} = 0V			−1.6	mA
BREQ (Note 3)					
Logic "1" Input Voltage		V_{SS} − 1		V_{SS} + 0.3	V
Logic "0" Input Voltage				0.8	V
X1, X2 (Note 4)					
Logic "1" Input Voltage		3.0		V_{SS} + 0.3	V
Logic "0" Input Voltage				0.4	V
Logic "1" Input Current	V_{IN} = 3.0V			5.0	mA
Logic "0" Input Current	V_{IN} = 0.4V	−5.5			mA
Input Capacitance (All pins except V_{GG} and V_{SS})				10	pF
Supply Current					
I_{GG} (See Typical Plot of Normalized I_{GG} [and I_{SS}] Versus Ambient Temperature on page 6.)	T_A = 0°C, loads on all outputs: I_{SINK} = 1.6mA (See diagram, Simulated Current Load, on page 6.)		100	135	mA
I_{SS}			90	125	mA
OUTPUT SPECIFICATIONS					
BREQ (Note 3)					
Logic "1" Output Current	V_{OUT} = (V_{SS} − 1)V	−2.0			mA
Logic "0" Output Current	$V_{GG} \leq V_{OUT} \leq V_{SS}$			±10	μA
External Load Capacitance				50	pF
All Other Outputs					
Logic "1" Output Voltage	I_{OUT} = −80μA I_{OUT} = −200μA	V_{SS} − 1 2.4			V V
Logic "0" Output Voltage	I_{OUT} = 1.6mA			0.4	V
Logic "0" Output Current	V_{OUT} = −0.5V			4.0	mA
Logic "0" Output Voltage	I_{OUT} = 0mA (unloaded)	−3.0	−0.7		V

*Typical parameters correspond to nominal supply voltage at 25°C.

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electrical characteristics ($T_A = 0°C$ to $+70°C$, $V_{SS} = +5V \pm 5\%$, $V_{GG} = -7V \pm 5\%$) (continued)

Parameter	Conditions	Min.	Typ.*	Max.	Units
TIMING SPECIFICATIONS (Note 5)					
T_x (Notes 4 and 6)		1.0		10.0	μs
	820pF ± 10% across X1 & X2	1.0		4.0	μs
f_{res}	crystal with equivalent series resistance ≤ 600Ω	900		1000	kHz
Address and Input/Output Status (See figures 5 and 6.)					
T_{D1} (ADS)		$(3T_x/2) - 150$	$3T_x/2$	$(3T_x/2) + 200$	ns
T_W (ADS)		$(T_x/2) - 250$			ns
T_S (ADDR)		$(T_x/2) - 300$			ns
T_H (ADDR)		30	50		ns
T_S (STAT)		$(T_x/2) - 300$			ns
T_H (STAT)		30	50		ns
Data Input Cycle (See figure 5.)					
T_D (RDS)		−80	−50		ns
T_W (RDS)		$(3T_x/2) - 400$			ns
T_S (RD)		300			ns
T_H (RD)		0			ns
T_{ACC} (RD)		$2T_x - 400$			ns
Data Output Cycle (See figure 6.)					
T_D (WDS)		$T_x - 250$			ns
T_W (WDS)		$T_x - 250$			ns
T_S (WD)		$(T_x/2) - 300$			ns
T_H (WD)		60	100		ns
Input/Output Cycle Extend (See figure 7.)					
T_S (HOLD)		300			ns
T_{D1} (HOLD)				300	ns
T_{D2} (HOLD)				500	ns
T_W (HOLD)				∞	ns
Bus Access (See figure 4.)					
T_D (ENOUT)				300	ns
T_{D2} (ADS)		$(T_x/2) - 350$		$T_x + 500$	ns
OUTPUT LOAD CAPACITANCE					
External Load Capacitance				75	pF

Note 1: Maximum ratings indicate limits beyond which permanent damage may occur. Continuous operation at these limits is not intended and should be limited to those conditions specified under electrical characteristics.

Note 2: Pullup transistors provided on chip for TTL compatibility.

Note 3: BREQ is an input/output signal that requires an external resistor to V_{GG} or ground.

Note 4: X_1 and X_2 are master timing inputs that are normally connected to a 1-megahertz crystal or an external capacitor to control the frequency of the on-chip oscillator.

A hermetically sealed quartz crystal is recommended. The crystal must be a series-resonant type and its equivalent series resistance must not exceed 600 ohms. Suppression of third harmonic oscillations may be required depending on the characteristics of the crystal. Typically, a 500-picofarad capacitor across pin X_1 or X_2 and an AC ground minimizes third harmonic effects.

If use of an external oscillator is desired, the circuit shown in figure 3 or an equivalent may be used.

Note 5: All times measured from valid Logic "0" or Logic "1" level.

Note 6: T_x is the time period for one clock cycle of the on-chip or external oscillator. Refer to paragraph titled Timing Control for detailed definition.

*Typical parameters correspond to nominal supply voltage at 25°C.

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functional description

SC/MP is a self-contained general-purpose microprocessor designed for ease of implementation in stand-alone, DMA (Direct Memory Access), and multiprocessor applications. Communications between SC/MP and external memory/peripheral devices are effected via a 12-bit dedicated address bus and an 8-bit bidirectional data bus. During the address interval of each input/output cycle, SC/MP employs both busses to provide a 16-bit address output: the 12 least significant address bits are sent out over the 12-bit address bus and the 4 most significant address bits are sent out over the 8-bit data bus along with 4 status bits. Separate strobe outputs from SC/MP (NADS, NWDS, NRDS) indicate when valid address information is present on the two busses, and when valid input/output memory or peripheral data are present on the 8-bit bus. To further extend flexibility of application, serial data input/output ports are also provided so that serial data transfers can be effected under program control. The remaining input/output signals shown in figure 1 are dedicated to general-purpose control and status functions, including initialization, bus management, microprocessor halt, interrupt request, input/output cycle extension, and user-specified hardware/software interface functions. A detailed description of each input/output signal is provided in table 1.

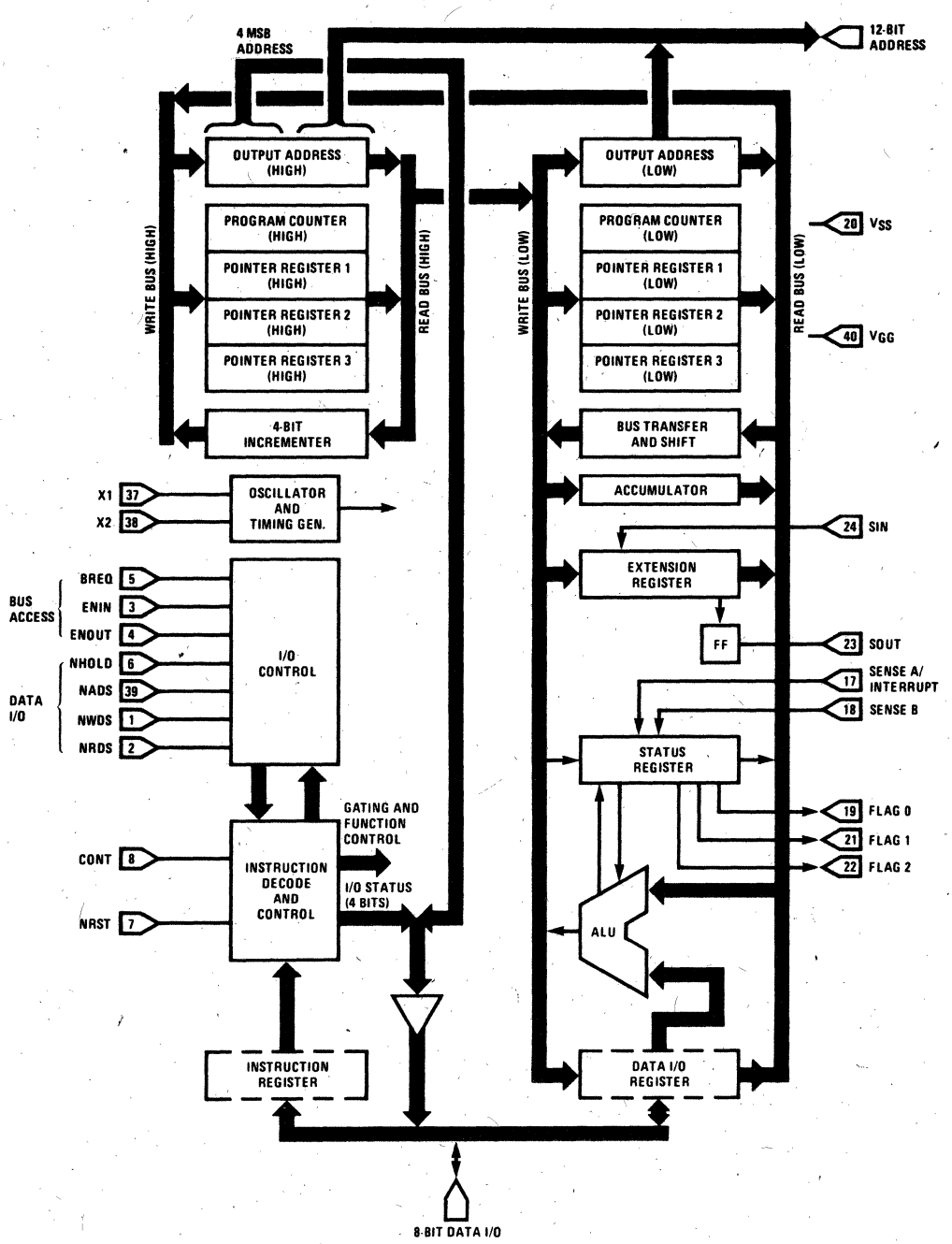

FIGURE 1. SC/MP Detailed Block Diagram

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TABLE 1. Input/Output Signal Description

Signal Mnemonic	Functional Name	Description
NRST	Reset Input	Set high for normal operation. When set low, aborts in-process operations. When returned high, internal control circuit zeroes all programmer-accessible registers; then, first instruction is fetched from memory location 0001_{16}.
CONT	Continue Input	When set high, enables normal execution of program stored in external memory. When set low, SC/MP operation is suspended (after completion of current instruction) without loss of internal status.
BREQ	Bus Request Input/Output	Associated with SC/MP internal allocation logic for system bus. Can be used as bus request output or bus busy input. Requires external load resistor to V_{GG}.
ENIN	Enable Input	Associated with SC/MP internal allocation logic for system bus. When set high, SC/MP is granted access to system busses. When set low, places system busses in high-impedance (TRI-STATE®) mode.
ENOUT	Enable Output	Associated with SC/MP internal allocation logic for system bus. Set high when ENIN is high and SC/MP is not using system busses (BREQ-low). Set low at all other times.
NADS	Address Strobe Output	Active-low strobe. While low, indicates that valid address and status output are present on system busses.
NRDS	Read Strobe Output	Active-low strobe. On trailing edge, data are input to SC/MP from 8-bit bidirectional data bus. High-impedance (TRI-STATE®) output when input/output cycle is not in progress.
NWDS	Write Strobe Output	Active-low strobe. While low, indicates that valid output data are present on 8-bit bidirectional data bus. High-impedance (TRI-STATE®) output when input/output cycle not in progress.
NHOLD	Input/Output Cycle Extend Input	When set low prior to trailing edge of NRDS or NWDS strobe, stretches strobe to extend input/output cycle; that is, strobe is held low until NHOLD signal is returned high.
SENSE A	Sense/Interrupt Request Input	Serves as interrupt request input when SC/MP internal IE (Interrupt Enable) flag is set. When IE flag is reset, serves as user-designated sense condition input. Sense condition testing is effected by copying status register to accumulator.
SENSE B	Sense Input	User-designated sense-condition input. Sense-condition testing is effected by copying status register to accumulator.
SIN	Serial Input to E Register	Under software control, data on this line are right-shifted into E register by execution of SIO instruction.
SOUT	Serial Output from E Register	Under software control, data are right-shifted onto this line from E register by execution of SIO instruction. Each data bit remains latched until execution of next SIO instruction.
FLAGS 0, 1, 2	Flag Outputs	User-designated general-purpose flag outputs of status register. Under program control, flags can be set and reset by copying accumulator to status register.
AD00-AD11	Address Bit 00 through Address Bit 11	Twelve TRI-STATE® address output lines. SC/MP outputs 12 least significant address bits on this bus when NADS strobe is low. Address bits are then held valid until trailing edge of read (NRDS) or write (NWDS) strobes. After trailing edge of NRDS or NWDS strobe, bus is set to high-impedance (TRI-STATE®) mode until next NADS strobe.

NOTE:

The 8-bit bidirectional data bus is set to the high-impedance (TRI-STATE®) mode except when it is actually in use by SC/MP (NADS, NRDS, or NWDS low). During the addressing interval of each input/output cycle (NADS low), SC/MP provides address and status outputs over the bus; during the ensuing data-transfer interval (NRDS or NWDS low), 8-bit input or output data bytes are routed over the bus.

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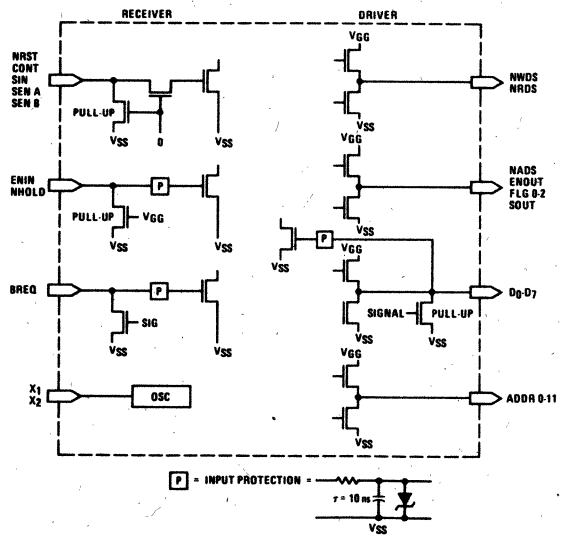
TABLE 1. Input/Output Signal Description (Continued)

Signal Mnemonic/ Pin Designation	Output at NADS Time		Input at NRDS Time	Output at NWDS Time
	Functional Name	Description		
DB0	Address Bit 12	Fourth most significant bit of 16-bit address.	Input data are expected on the eight (DB0-DB7) lines.	Output data are valid on the eight (DB0-DB7) lines.
DB1	Address Bit 13	Third most significant bit of 16-bit address.		
DB2	Address Bit 14	Second most significant bit of 16-bit address.		
DB3	Address Bit 15	Most significant bit of 16-bit address.		
DB4	R-Flag	When high, data input cycle is starting; when low, data output cycle is starting.		
DB5	I-Flag	When high, first byte of instruction is being fetched.		
DB6	D-Flag	When high, indicates delay cycle is starting; that is, second byte of DLY instruction is being fetched.		
DB7	H-Flag	When high, indicates that Halt Instruction has been executed. (In some system configurations, the H-Flag output is latched and, in conjunction with the CONTinue input, provides a programmed halt.)	**Note:** The DB0 through DB7 (AD12-HFLG) lines are a high-impedance (open circuit) load when SC/MP does not have access to the input/output bus.	

DRIVERS AND RECEIVERS

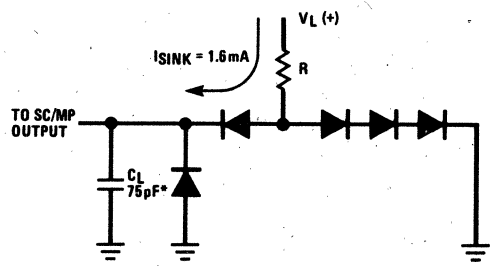
Equivalent circuits for SC/MP drivers and receivers are shown below. All inputs have static charge protection circuits consisting of an RC filter and voltage clamp. These devices still should be handled with care, as the protection circuits can be destroyed by excessive static charge.



SC/MP Driver and Receiver Equivalent Circuits

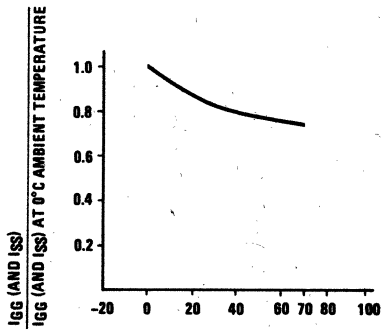
SUPPLY CURRENT DATA

Below are the two diagrams referenced from the parametric specification for the supply current, page 2.



*INCLUDES JIG CAPACITANCE.

Simulated Current Load



TYPICAL PLOT OF NORMALIZED I_{GG} (AND I_{SS}) VERSUS AMBIENT TEMPERATURE

DC POWER = $I_{GG} \cdot V_{GG} + I_{SS} \cdot V_{SS}$

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TIMING CONTROL

All necessary timing signals are provided by an on-chip oscillator and a timing generator. The frequency of the oscillator, in turn, is selected by connecting an external capacitor or crystal between pins 37 and 38 (X1 and X2). When a crystal is used, the resulting frequency of the oscillator is equal to the resonant frequency of the crystal; when a capacitor is used, the frequency of the oscillator varies according to the capacitance value as shown in figure 2.

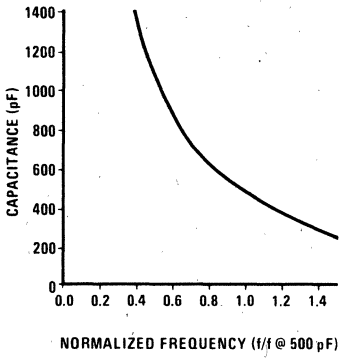

FIGURE 2. Oscillator Frequency versus Capacitance

If desired, the on-chip oscillator can be disabled and the timing generator can be driven by an externally generated clock. In this case, the clock comprises single-phase true and complement inputs. One input is applied to X1 and the other to X2. (A clock is generated at twice the SC/MP clock frequency and is divided by two by a flip-flop as shown in figure 3.)

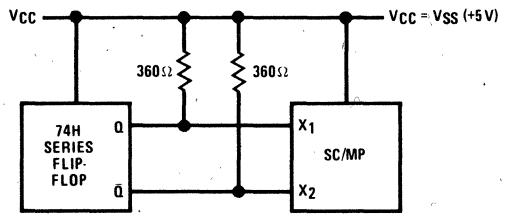

FIGURE 3. External Clock Generation

In the discussions that follow, instruction execution and input/output timing are described in terms of microcycles. For purposes of definition, the time interval of a microcycle is computed according to the following formula:

$$1 \text{ microcycle} = 2T_X$$

where

T_X = time period of oscillator = $\frac{1}{f_{osc}} = \frac{1}{f_{res}} = \frac{1}{\text{External Clock Frequency}}$

f_{osc} = frequency of on-chip oscillator

f_{res} = resonant frequency of quartz crystal connected between pins 37 and 38

INSTRUCTION FORMAT

The SC/MP instruction repertoire includes both single-byte and double-byte instructions. A single-byte instruction consists of an 8-bit operation code that specifies an operation that SC/MP can execute without further reference to memory. A double-byte instruction consists of an 8-bit operation code and an 8-bit data or displacement field. When the second byte represents a data field, the data are processed by SC/MP during execution of the instruction, thereby eliminating the need for further memory references. When the second byte represents a displacement value, it is used to calculate a memory address that will be accessed (written into or read from) during execution of the instruction (refer to Addressing).

DATA STORAGE

As shown in figure 1, SC/MP provides ten internal registers, seven of which are accessible to the programmer. The purpose and function of these registers are described below.

Program Counter – The program counter is a 16-bit register that contains the address of the instruction being executed. The contents of this register are automatically incremented by one just before each instruction is fetched from memory to enable sequential execution of the stored instruction. Under program control, the contents of this register also may be modified or exchanged with the contents of a pointer register to effect subroutine calls and program branches.

NOTE:

The 16-bit address output of the program counter consists of a 4-bit high-order address and a 12-bit low-order address. When the program counter is incremented at the start of each instruction fetch input/output cycle, only the 12 low-order bits are affected; no carry is provided to the 4 high-order bits. For systems employing memories of 4k or less, the high-order bits can be ignored as they are set to 0000_{16} following initialization. For systems employing larger memories, the contents of a pointer register can be modified to select the desired 4k block of memory.

Pointer Registers – The pointer registers are 16-bit general-purpose registers that are loaded normally under program control with reference addresses that serve as page pointers, stack pointers, and subroutine pointers. In applications having minimal memory addressing requirements, these registers may be used alternately as data storage registers.

NOTE:

When interrupt requests are enabled, pointer register 3 is automatically referenced by the internal microprogram for formation of the starting address of the user-generated interrupt service routine. (See figure 8.) In this case, the contents of pointer register 3 must be set to one less than the memory location of the first instruction in the interrupt service routine.

Accumulator – The 8-bit accumulator (AC) is the primary working register of SC/MP. It is used for performing and storing the results of arithmetic and logic operations as well as for data transfers, shifts, rotates, and data exchanges with the program counter, the pointer registers, and the status register.

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Extension Register — The extension register is used both for serial input/output data transfers and with the accumulator to effect arithmetic, logic, and data-transfer operations. If the second byte of an indexed or auto-indexed memory-reference instruction (refer to Addressing) equals -128_{10}, the contents of the extension register are used as the displacement value for address formation.

Status Register — The status register provides storage for arithmetic, control, and software status flags. For more-detailed information on the function of this register, refer to Status Register under the description of the Arithmetic and Logic Unit.

Instruction Register — The 8-bit instruction register is not accessible to the programmer. During the fetch phase of each instruction cycle, this register is loaded with the 8-bit instruction operation code retrieved from memory (for a single-byte instruction or the first byte of a double-byte instruction).

Data Input/Output Register — The data input/output register is not accessible to the programmer. It is used for temporary storage of all input/output data received via or transmitted over the 8-bit bidirectional data bus during the data-transfer interval of each input/output cycle (NRDS or NWDS low).

Address Register — The 16-bit address register is not accessible to the programmer. It is used for temporary storage of the 16-bit address transmitted during an input/output cycle.

ARITHMETIC AND LOGIC UNIT

The Arithmetic and Logic Unit (ALU) provides the data-manipulation capability that is an essential feature of any microprocessor. The operations provided by the ALU include OR, XOR, increment, decrement, binary addition, and decimal addition. For decimal addition, the data inputs to the ALU are treated as two 4-bit BCD digits, thereby eliminating the program-storage and execution time required to perform BCD to binary conversion.

BUS TRANSFER LOGIC

The bus transfer logic processes the gating and function control outputs of the instruction-decode logic to provide the shift-right (with link, without link, or with serial input data), rotate (with or without link), and bus-exchange functions necessary for data movement between the SC/MP internal read and write busses. A general summary of the data-manipulation capabilities available to the programmer follows.

1. Either the low-order or the high-order byte of any pointer register can be exchanged with the contents of the 8-bit accumulator. Thus, data exchanges between the pointer registers can be effected one byte at a time via the accumulator.

2. The contents of the program counter can be directly exchanged with the contents of any pointer register.

3. The contents of the extension register can be loaded into the accumulator or can be exchanged with the contents of the accumulator. When the accumulator is loaded from the extension register, the original contents of the accumulator are lost.

4. The contents of the status register can be copied into the accumulator to enable status modification or conditional-branch testing. When the status register is copied into the accumulator, the contents of the status register are not altered but the original contents of the accumulator are lost.

5. The contents of the accumulator can be copied into the status register to change the outputs of the status register, except for status bits 4 and 5 (Sense A and B inputs to SC/MP). Since these are read-only bits, they are not affected by data movements internal to SC/MP. Copying the accumulator into the status register does not alter the contents of the accumulator.

NOTE:

The flag 0, 1, and 2 outputs of the status register serve as latched flags; in other words, they are set to the specified state when the contents of the accumulator are copied into the status register, and they remain in the specified state until the contents of the status register are modified again under program control.

STATUS REGISTER

The function of each bit in the status register is described briefly below.

7	6	5	4	3	2	1	0
CY/L	OV	S_B	S_A	IE	F_2	F_1	F_0

User Flag 0 — User-assigned general-purpose status bit for implementation as software status bit or in system control applications. This status bit is available as an external output from SC/MP.

User Flag 1 — Same as User Flag 0.

User Flag 2 — Same as User Flag 0.

Interrupt Enable Flag — Internal status bit that is set and reset under program control. When set, SC/MP recognizes external interrupt requests received via Sense A input. When reset, inhibits SC/MP from recognizing interrupt requests.

Sense A — General-purpose status input for sensing external conditions. When IE flag is reset, this bit can be tested by copying status register to accumulator. When IE flag is set, this bit serves as interrupt request input causing SC/MP to automatically branch to user-generated interrupt-service routine in response to high input.

Sense B — Same as Sense A except that it is not tested for interrupt status.

NOTE:

Sense A and B inputs are read-only bits. Thus, they are not affected when the contents of the accumulator are copied into the status register.

Overflow (OV) — This bit is set if an arithmetic overflow occurs during an add (ADD, ADI, or ADE) or a complement-and-add instruction (CAD, CAI, or CAE). It is not affected by the decimal-add instructions (DAD, DAI, or DAE).

Carry/Link (CY/L) — This bit is set if a carry from the most significant bit occurs during an add, complement-and-add, or decimal-add instruction. Thus, it serves as a carry input to the next add instruction. In addition, it is included in the Shift Right with Link (SRL) and Rotate Right with Link (RRL) instructions.

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CONTROL

The operation of the SC/MP microprocessor consists of repeatedly accessing or fetching instructions from the program stored in external memory and executing the operations specified by the instructions. These two steps are carried out under the control of an internal microprogram. (SC/MP is not user-microprogrammable.) The microprogram is similar to a state table specifying the series of states of system control signals necessary to carry out each instruction. Microprogram storage is provided in the instruction decode and control logic, and microprogram routines are implemented to fetch and execute instructions. The fetch routine first increments the program counter, and then causes the instruction address to be transferred from the program counter to the system busses via the output address register. The microprogram next initiates an input data transfer. When the instruction operation code is subsequently placed on the 8-bit data bus (single-byte instruction or first byte of double-byte instruction), the operation code is loaded into the instruction register. The operation code is then partially decoded to determine whether the instruction contains a second byte. If it does, a second input data transfer is effected to load the next byte in the data input/output register.

After the complete instruction is stored in the instruction and/or data input/output register(s), the instruction decoder transforms the instruction operation code into the address of the appropriate instruction-execution routine contained in the internal microprogram. The microprogram then branches to the specified internal address to initiate execution of the instruction. The resulting execution routine comprises one or more microinstructions that implement the required functions. For example, the first microcycle of an Extension Register Add Instruction (ADE) causes the contents of the extension register to be gated onto the read bus, transferred to the write bus via the bus control logic, and then written into the data input/output register. The next microcycle causes the contents of the accumulator to be gated onto the read bus, the contents of the read bus to be added to the contents of the data input/output register via the ALU, and the resultant output of the ALU to be written into the accumulator via the write bus. The final step of the execution routine is a jump back to the fetch routine to access the next instruction.

INITIALIZATION

Since SC/MP may power up in a random condition, the following power-up and initialization procedure is recommended.

1. Apply power (V_{SS} and V_{GG}) and set NRST low.

   NOTE:

   Allow ample time (typically, 100ms) for the oscillator and the internal clocks to stabilize. In systems where NRST is set low after turning on power, NRST must remain low for a minimum of $4T_X$. While NRST is low, any in-process operations are aborted automatically. When NRST is low, strobes and address and data busses are in the Non-I/O state (high-Z state).

2. Set NRST high.

   NOTE:

   This causes the SC/MP internal control circuit to set the contents of all programmer-accessible registers to zero. Thus, when SC/MP is granted access to the system busses following initialization, the first instruction is fetched *always* from memory location 0001_{16}. The BREQ output goes high, indicating the start of this input/output cycle; this occurs at a time within $13T_X$ after NRST is set high. Normal execution of the program continues as long as NRST remains high.

parallel data transfers

Parallel data transfers occur during each instruction fetch and during the ensuing read/write cycle associated with execution of the memory-reference instructions. This class of instruction could perhaps more properly be called the "Input/Output Reference Class" in the case of the SC/MP microprocessor, since all data transfers, whether with memory, peripheral devices, or a central processor data bus, occur through the execution of these instructions. This unified bus structure is in contrast with many other microprocessors and minicomputers that have one instruction type (input/output class) for communication with peripheral devices and another instruction type (memory reference class) for communication with memories. The advantage of the approach taken by SC/MP is that a wider variety of instructions (the entire memory-reference class) is available for communications with peripherals. Thus, the LD and ST (Load and Store) instructions can be used for basic transfers, the ILD and DLD (increment/decrement and load) instructions can be used for indexing peripheral registers, and the remaining memory reference instructions can be used, as required, for "one-step" retrieval and processing of peripheral input data.

BUS ACCESS

Before SC/MP can initiate parallel data transfers with memory or peripheral devices, it must have access to the system address and data busses. Three of the SC/MP input/output signals are associated with bus control: BREQ, ENIN, and ENOUT. For simple stand-alone applications, the ENOUT signal can be ignored and the ENIN signal can be tied to V_{SS} to allow the SC/MP microprocessor to have continual access to the system busses. The BREQ input/output line then goes high during each input/output cycle as shown in figures 5 and 6 to indicate when SC/MP is actually using the system busses.

NOTE:

The BREQ input/output line must be tied to V_{GG} (or ground in +5-volt/-7-volt systems) via an external load resistor to allow normal operation of the SC/MP microprocessor.

For DMA and multiprocessor applications, the BREQ, ENIN, and ENOUT signals can be interconnected in various configurations to allow bus access to be granted to requesting devices according to user-specified priorities. Figure 4 illustrates the general sequence in which these signals are processed by SC/MP to gain access to the system busses and to indicate when the busses are actually being used.

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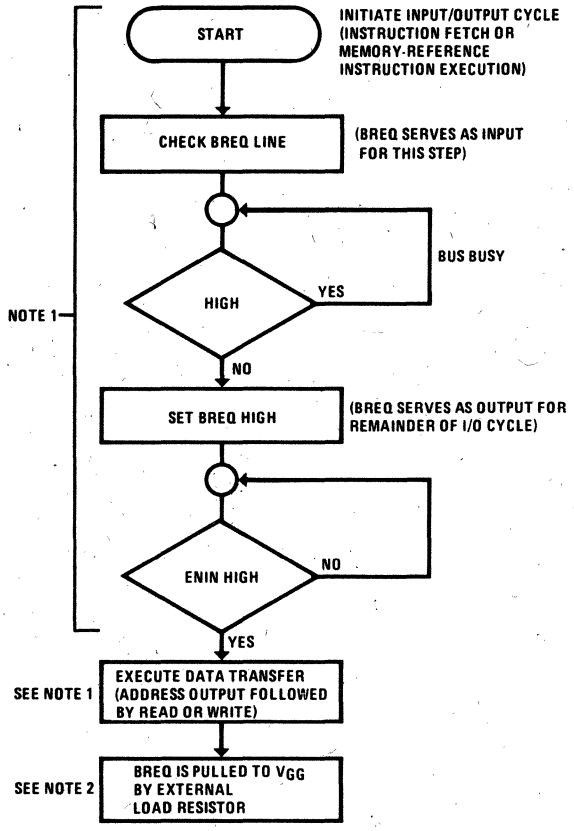
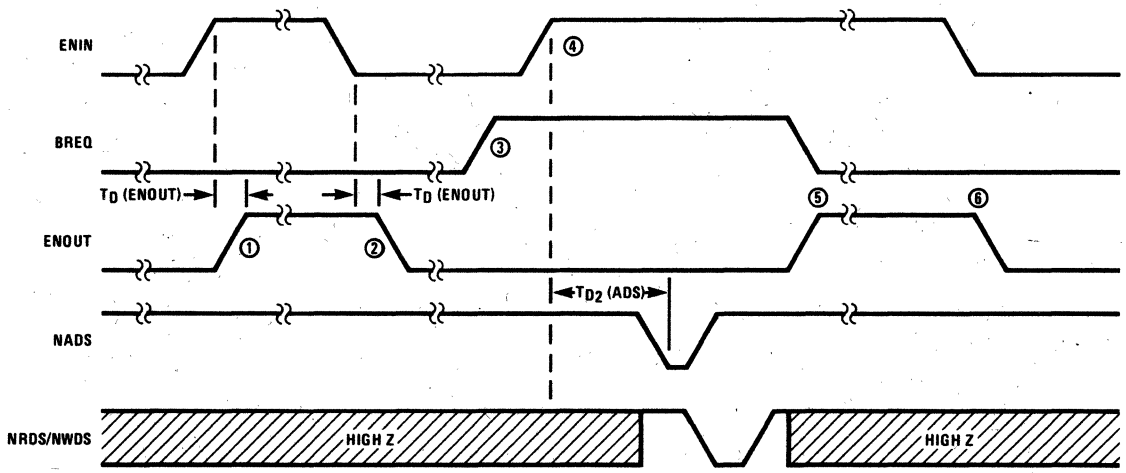
A. BREQ AND ENIN PROCESSING SEQUENCE



Note 1: ENOUT is always low while SC/MP is actually using bus; that is, ENIN input and BREQ output are high.

Note 2: When SC/MP is not using bus (BREQ output or ENIN input low), ENOUT is held in same state as ENIN input.

B. BREQ, ENIN, and ENOUT Timing



Note 1: ENOUT goes high to indicate that SC/MP was granted access to bus (ENIN high) but is not using bus.

Note 2: ENOUT goes low in response to low ENIN input.

Note 3: SC/MP generates bus request; bus access not granted because ENIN low.

Note 4: ENIN goes high. Bus access now granted and input/output cycle actually initiated. If ENIN is set low while SC/MP has access to the bus, the address and data ports will go to the high-impedance (TRI-STATE®) state, but BREQ will remain high. When ENIN is subsequently set high, the input/output cycle will begin again.

Note 5: I/O cycle completed. ENOUT goes high to indicate that SC/MP granted access to bus but not using bus. If ENIN had been set low before completion of input/output cycle, ENOUT would have remained low.

Note 6: ENOUT goes low to indicate that system busses are available for use by highest-priority requestor.

FIGURE 4. Bus Access Control

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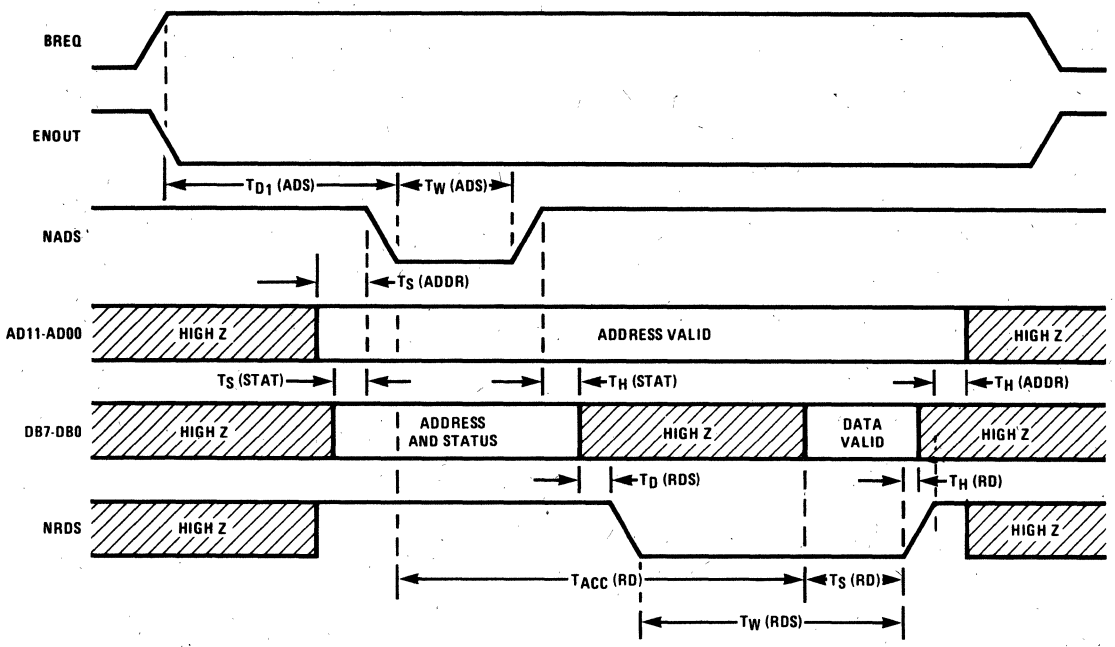

Note: Timing is valid when ENIN is wired high or is set high before BREQ is set high by SC/MP; see figure 4 for NADS timing when ENIN is set high after BREQ.

FIGURE 5. SC/MP Data Input Timing

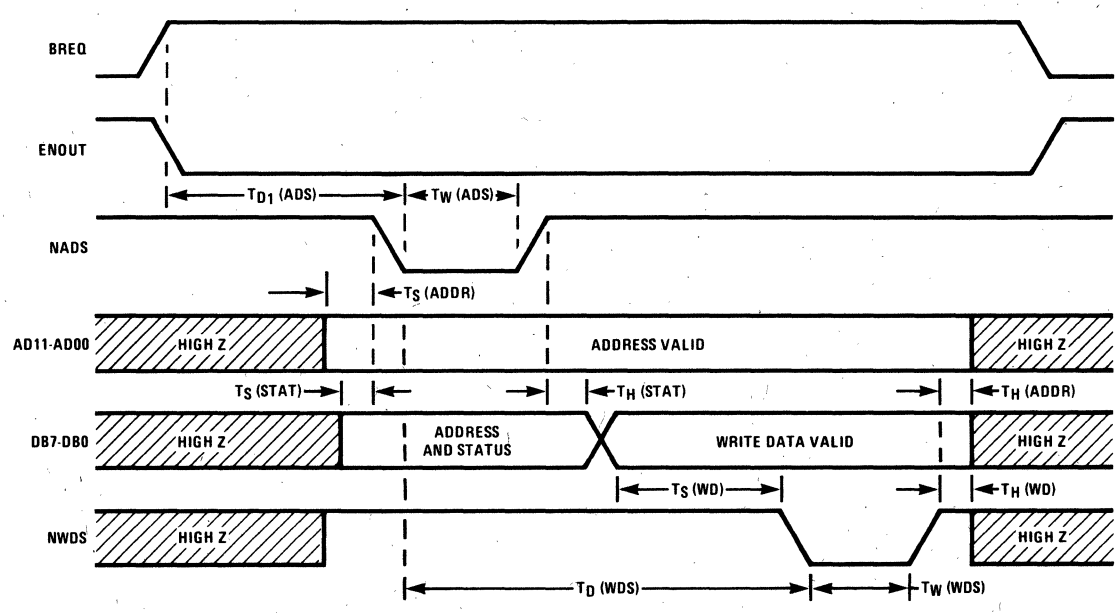

FIGURE 6. SC/MP Data Output Timing

INPUT/OUTPUT CYCLE

Once SC/MP has control of the system busses, the actual input/output cycle begins. As shown in figures 5 and 6, the functions of memory addressing, data reading, and data writing are implemented, respectively, by the address strobe (NADS), the read strobe (NRDS), and the write strobe (NWDS). Note that the BREQ signal is reset low at the end of the input/output cycle to indicate that the system busses are now free for use by the highest-priority requesting device.

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The first operation that SC/MP performs for each input/output cycle is to load the 12 least significant address bits onto the 12-bit address bus, and the 4 most significant address bits along with 4 status bits onto the 8-bit data bus. At the same time, SC/MP sets the NADS output low to indicate that the address and the status information are valid. The low-order address on the 12-bit bus is then held valid for the duration of the input/output cycle; the high-order address and the status information on the 8-bit bus remain valid only while NADS is low. While valid, the status bits have the following significance:

RFLG – When high, indicates that input/output cycle is read cycle; when low, indicates that input/output cycle is write cycle.

IFLG – Set high to indicate that instruction operation code (single-byte instruction or first byte of double-byte instruction) will be output from memory following NADS.

DFLG – Set high only when second byte of Delay Instruction is to be read from memory following NADS. Execution of the Delay Instruction then starts at trailing edge of NRDS. Upon completion, SC/MP provides NADS output to initiate next input/output cycle if bus access is granted. Time in microcycles from leading edge of delay flag to leading edge of subsequent NADS output is computed from the following formula:

$$\text{Delay} = [9 + 2(\text{AC}) + 2\ \text{disp} + 2^9\ \text{disp}]\ \text{microcycles}$$

where

(AC) = unsigned contents of accumulator

disp = unsigned displacement value contained in second byte of Delay Instruction

The time derived from the above formula does not include the four microcycles required to fetch the first byte of the Delay Instruction. Thus, when the Delay Instruction is used for software timing, total instruction execution time equals $[13 + 2(\text{AC}) + 2\ \text{disp} + 2^9\ \text{disp}]$ microcycles.

NOTE:

When Halt Instruction is executed, instruction decode and control logic inhibits incrementing of program counter for one input/output cycle. Thus, Halt Instruction is read from memory a second time to enable generation of HFLG output, but no further processing of Halt Instruction occurs. In effect, this procedure ensures HFLG is output in advance of the next instruction to be fetched from memory.

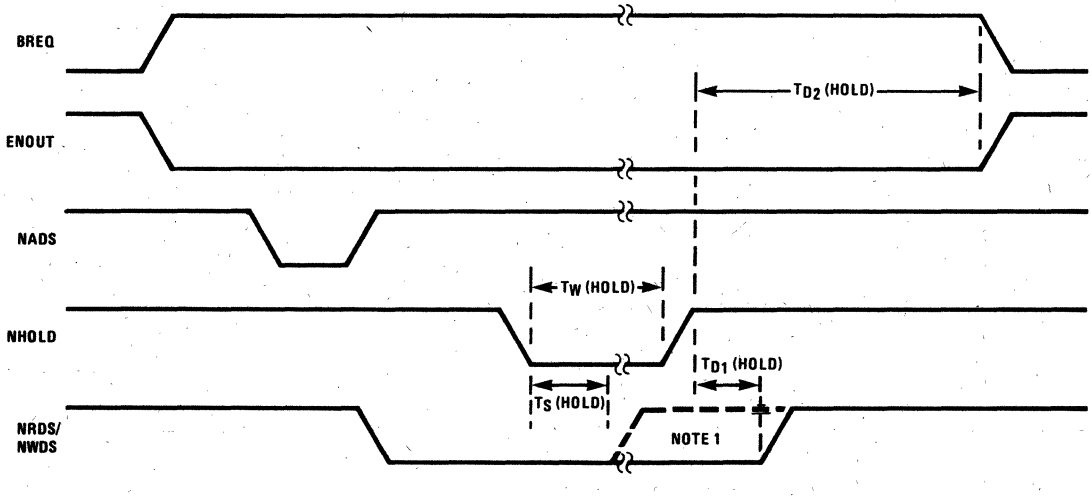
HFLG – Set high only during addressing interval of read cycle that follows Halt Instruction. HFLG may be used to cause user-provided external logic to set the CONT input low, and thereby to effect a programmed halt. Since HFLG read cycle precedes the next instruction fetch, termination of programmed halt enables fetch of first instruction that follows Halt Instruction.

After resetting the NADS output, SC/MP generates an NRDS or NWDS strobe, respectively, to initiate a data-input (read) or data-output (write) operation. For a read operation, input data are strobed into SC/MP from the 8-bit bus on the trailing edge of the NRDS strobe. For a write operation, SC/MP places valid output data on the 8-bit bus on the leading edge of the NWDS strobe. After resetting the NRDS or NWDS strobe to complete the data transfer, SC/MP then resets the BREQ signal to indicate that the system busses are free for use by another controller.

input/output cycle extension

For systems employing memories or peripherals with long access times it may be desirable to utilize the NHOLD input to lengthen the input/output cycle. As shown in figure 7, setting the NHOLD signal low prior to the trailing edge of the NRDS or NWDS strobe causes SC/MP to hold the strobe active until after the NHOLD signal is returned high.

The NHOLD signal can also be used for single-cycle execution of the operating program as required for debugging software.



Note: Dashed trailing edge of NRDS/NWDS indicates normal strobe timing when NHOLD is not active.

FIGURE 7. Extended Input/Output Timing

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serial data transfers

Serial input/output data transfers can be used efficiently with very slow input/output peripherals such as X-Y plotters, teletypewriters, slow-speed printers, and so forth. Such transfers can be effected in any of the following manners:

1. By assigning serial input/output functions to the extension register via the SIO (Serial Input/Output) Instruction. When this instruction is executed, the contents of the extension register are shifted right one bit. At the same time, data present on the SIN line are shifted into bit position 7 of the extension register and the original contents of bit position 0 are shifted into a flip-flop to provide a latched output of the SOUT line. The SOUT data are then held latched until the next SIO instruction is executed.

2. By using one of the status flags as an output data bit and one of the sense lines as an input data bit.

3. By implementing external logic such that only one line of the 8-bit data input/output bus is used.

For synchronous systems, serial data input/output timing may be provided by program loops that employ the delay instruction, or by using one or more of the transfer instructions (see table 2) to test the output of an external timing circuit. For asynchronous systems, one of the sense inputs can be used for testing bit-received/ready status and a pulsed flag output can be provided, under program control, for peripheral indexing each time that a data bit is actually shifted in or out.

Systems that have several input/output devices must be multiplexed; device selection can then be accomplished using the status flag outputs of SC/MP, or by using parallel input/output commands to load an external latch. Systems that do not require serial input/output capability can employ the SIN and SOUT lines as a sense input and flag output, respectively.

interrupts

When the internal interrupt enable (IE) flag is set under program control, the Sense A line is enabled to serve as an interrupt request input; when the IE flag is reset, SC/MP is inhibited from detecting interrupts. Thus, while the IE flag is set, the Sense A input is tested prior to the fetch phase of each instruction as shown in figure 8. Upon detection of an interrupt request (Sense A high), the following events occur automatically.

1. The status register IE flag is reset to prevent SC/MP from responding to any further interrupt requests. Interrupt request capability can then be reenabled during or at the end of the ensuing user-generated interrupt service routine via the IEN (Enable Interrupt) Instruction or by copying the accumulator into the status register.

2. The contents of the program counter are exchanged with the contents of the pointer register 3.

3. The contents of the program counter are incremented by one to address the first instruction of the user-generated interrupt service routine.

The interrupt system must be armed before interrupts are enabled. This is accomplished as follows:

1. First, the Interrupt Enable Bit in the Status Register is set true by executing either an Enable Interrupt Instruction (IEN) or a Copy Accumulator to Status Register Instruction (CAS).

2. Second, one additional instruction is fetched and executed.

A return from interrupt is accomplished by executing two instructions: Enable Interrupt (IEN) immediately followed by Exchange Pointer 3 with Program Counter (XPPC 3).

microprocessor halt

The CONT input to SC/MP is provided to enable suspension of operation without loss of internal status. Processing of the CONT input is shown in figure 8. Since this is an asynchronous input, it can be controlled by external timing logic, or as stated previously, the HALT flag output that appears on the 8-bit data bus (during the read cycle that follows execution of a Halt Instruction) can be used with an external circuit to effect a programmed halt condition. Note that when an interrupt request is detected while the CONT input is low, the first instruction of the user-generated interrupt service routine is automatically executed. Thus, the first instruction of the interrupt service routine can be used to reset the external CONT input logic and, thereby, to terminate the microprocessor halt condition if so desired.

After execution of an instruction, the CONT input must be high for a minimum time of $2T_X$ (1 microcycle) in order to fetch and execute the next instruction.

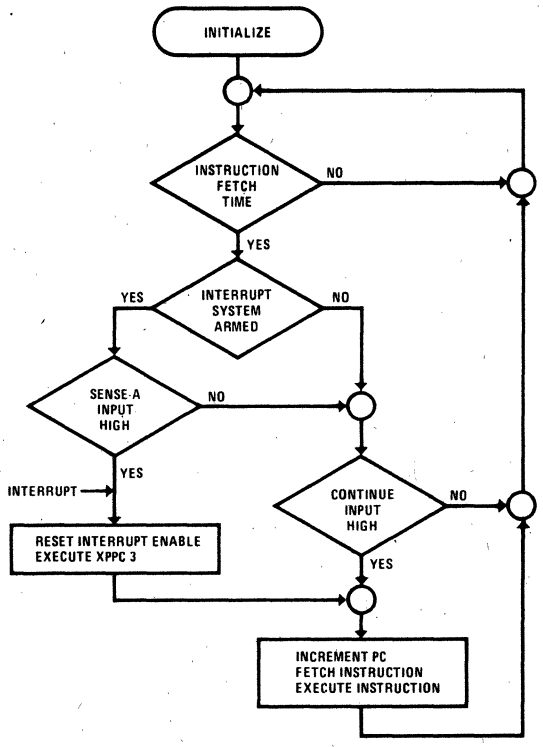

FIGURE 8.

Microprocessor Halt and Interrupt Request Input Processing

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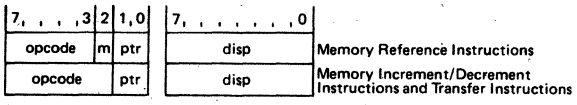
instruction set

The SC/MP instruction set provides the general-purpose user of microprocessors a powerful programming capability along with above-average flexibility and speed. The instruction set consists of 46 instructions, which comprise eight general categories. A listing of the complete instruction set is provided in table 2; typical instruction execution times are given in table 3, and notations and symbols used as shorthand expressions of instruction capability are defined in table 4.

ADDRESSING

During execution, instructions and data defined in a program are stored into and loaded from specific memory locations, the accumulator, or selected registers. Because SC/MP, memory (read/write and read-only), and peripherals are on a common data bus, any instruction used to address memory may be used to address the peripherals. The formats of the instruction groups that reference memory are shown below.



Memory-reference instructions use the PC-relative, indexed, or auto-indexed methods of addressing memory. The memory-increment/decrement instructions and the transfer instructions use the PC-relative or indexed methods of addressing.

The various methods of addressing memory and peripherals are shown below.

Immediate addressing is an addressing format specific to the immediate instruction group.

Type of Addressing	Operand Formats		
	m	ptr	disp
PC-relative	0	0	-128 to +127
Indexed	0	1, 2, or 3	-128 to +127
Immediate	1	0	-128 to +127
Auto-indexed	1	1, 2, or 3	-128 to +127

For PC-relative, indexed, and auto-indexed memory-reference instructions, another feature of the addressing architecture is that the contents of the extension register are substituted for the displacement if the instruction displacement equals -128 (-X'80).

NOTE:

All arithmetic operations associated with address formation affect only the 12 low-order address bits; no carry is provided to the 4 high-order bits. For systems employing memories of 4k or less, the high-order bits can be ignored as they are set to 0000 following initialization. For systems employing larger memories, the high-order bits must be set to the starting address of the desired 4k block of memory. For example:

0001_2 enables memory locations 1000_{16} - $1FFF_{16}$ to be addressed.

0010_2 enables memory locations 2000_{16} - $2FFF_{16}$ to be addressed and so forth.

PC-Relative Addressing – A PC-relative address is formed by adding the displacement value specified in the operand field of the instruction to the current contents of the program counter. The displacement is an 8-bit twos-complement number, so the range of the PC-relative addressing format is -128_{10} to $+127_{10}$ locations from the current contents of the program counter.

Immediate Addressing – Immediate addressing uses the value in the second byte of a double-byte instruction as the operand for the operation to be performed (see below).

For example, compare a Load (LD) instruction to a Load Immediate (LDI) instruction. The Load instruction uses the contents of the second byte of the instruction in computing the effective address of the data to be loaded. The Load Immediate instruction uses the contents of the second byte as the data to be loaded.

Indexed Addressing – Indexed addressing enables the programmer to address any location in memory through the use of the pointer register and the displacement. When indexed addressing is specified in an instruction, the contents of the designated pointer register are added to the displacement to form the effective address. The contents of the pointer register are not modified by indexed addressing.

Auto-Indexed Addressing – Auto-indexed addressing provides the same capabilities as indexed addressing along with the ability to increment or decrement the designated pointer register by the value of the displacement. If the displacement is less than zero, the pointer register is decremented by the displacement before the contents of the effective address are fetched or stored. If the displacement is equal to or greater than zero, the pointer register is used as the effective address, and the pointer register is incremented by the displacement after the contents of the effective address are fetched or stored.

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DOUBLE-BYTE INSTRUCTIONS

TABLE 2. SC/MP Instruction Summary

MNEMONIC	DESCRIPTION	OBJECT FORMAT	OPERATION	MICRO-CYCLES
	Memory Reference Instructions	7 6 5 4 3 2 1 0 | 7 6 5 4 3 2 1 0		
LD	Load	1 1 0 0 0 m ptr | disp	(AC)←(EA)	18
ST	Store	1 1 0 0 1	(EA)←(AC)	18
AND	AND	1 1 0 1 0	(AC)←(AC) ∧ (EA)	18
OR	OR	1 1 0 1 1	(AC)←(AC) ∨ (EA)	18
XOR	Exclusive-OR	1 1 1 0 0	(AC)←(AC) $\forall$ (EA)	18
DAD	Decimal Add	1 1 1 0 1	$(AC)\leftarrow(AC)_{10} + (EA)_{10} + (CY/L);(CY/L)$	23
ADD	Add	1 1 1 1 0	(AC)←(AC) + (EA) + (CY/L);(CY/L),(OV)	19
CAD	Complement and Add	1 1 1 1 1	(AC)←(AC) + ~(EA) + (CY/L);(CY/L),(OV)	20
	Memory Increment/Decrement Instructions	7 6 5 4 3 2 1 0 | 7 6 5 4 3 2 1 0		
ILD	Increment and Load	1 0 1 0 1 0 ptr | disp	(AC), (EA)←(EA) + 1	22
DLD	Decrement and Load	1 0 1 1 1 0	(AC), (EA)←(EA) - 1	22
	Immediate Instructions	7 6 5 4 3 2 1 0 | 7 6 5 4 3 2 1 0		
LDI	Load Immediate	1 1 0 0 0 1 0 0 | data	(AC)← data	10
ANI	AND Immediate	1 1 0 1 0 1 0 0	(AC)←(AC) ∧ data	10
ORI	OR Immediate	1 1 0 1 1 1 0 0	(AC)←(AC) ∨ data	10
XRI	Exclusive-OR Immediate	1 1 1 0 0 1 0 0	(AC)←(AC) $\forall$ data	10
DAI	Decimal Add Immediate	1 1 1 0 1 1 0 0	$(AC)\leftarrow(AC)_{10} + data_{10} + (CY/L);(CY/L)$	15
ADI	Add Immediate	1 1 1 1 0 1 0 0	(AC)←(AC) + data + (CY/L);(CY/L),(OV)	11
CAI	Complement and Add Immediate	1 1 1 1 1 1 0 0	(AC)←(AC) + ~data + (CY/L);(CY/L),(OV)	12
	Transfer Instructions	7 6 5 4 3 2 1 0 | 7 6 5 4 3 2 1 0		
JMP	Jump	1 0 0 1 0 0 ptr | disp	(PC)←EA	11
JP	Jump if Positive	1 0 0 1 0 1	If (AC) ⩾ 0, (PC)←EA	9, 11
JZ	Jump if Zero	1 0 0 1 1 0	If (AC) = 0, (PC)←EA	9, 11
JNZ	Jump if Not Zero	1 0 0 1 1 1	If (AC) ≠ 0, (PC)←EA	9, 11
	Double-Byte Miscellaneous Instructions	7 6 5 4 3 2 1 0 | 7 6 5 4 3 2 1 0		
DLY	Delay	1 0 0 0 1 1 1 1 | disp	count AC to -1, delay = 13 + 2(AC) + 2 disp + 2^9 disp microcycles	13 to 131,593

SINGLE-BYTE INSTRUCTIONS

MNEMONIC	DESCRIPTION	OBJECT FORMAT	OPERATION	MICRO-CYCLES
	Extension Register Instructions	7 6 5 4 3 2 1 0		
LDE	Load AC from Extension	0 1 0 0 0 0 0 0	(AC)←(E)	6
XAE	Exchange AC and Extension	0 0 0 0 0 0 0 1	(AC)↔(E)	7
ANE	AND Extension	0 1 0 1 0 0 0 0	(AC)←(AC) ∧ (E)	6
ORE	OR Extension	0 1 0 1 1 0 0 0	(AC)←(AC) ∨ (E)	6
XRE	Exclusive-OR Extension	0 1 1 0 0 0 0 0	(AC)←(AC) $\forall$ (E)	6
DAE	Decimal Add Extension	0 1 1 0 1 0 0 0	$(AC)\leftarrow(AC)_{10} + (E)_{10} + (CY/L);(CY/L)$	11
ADE	Add Extension	0 1 1 1 0 0 0 0	(AC)←(AC) + (E) + (CY/L);(CY/L),(OV)	7
CAE	Complement and Add Extension	0 1 1 1 1 0 0 0	(AC)←(AC) + ~(E) + (CY/L);(CY/L),(OV)	8
	Pointer Register Move Instructions	7 6 5 4 3 2 1 0		
XPAL	Exchange Pointer Low	0 0 1 1 0 0 ptr	$(AC)\leftrightarrow(PTR_{7:0})$	8
XPAH	Exchange Pointer High	0 0 1 1 0 1	$(AC)\leftrightarrow(PTR_{15:8})$	8
XPPC	Exchange Pointer with PC	0 0 1 1 1 1	(PC)↔(PTR)	7
	Shift, Rotate, Serial I/O Instructions	7 6 5 4 3 2 1 0		
SIO	Serial Input/Output	0 0 0 1 1 0 0 1	$(E_i)\rightarrow(E_{i-1})$, SIN→$(E_7)$, (E_0)→SOUT	5
SR	Shift Right	0 0 0 1 1 1 0 0	$(AC_i)\rightarrow(AC_{i-1})$, 0→$(AC_7)$	5
SRL	Shift Right with Link	0 0 0 1 1 1 0 1	$(AC_i)\rightarrow(AC_{i-1})$, (CY/L)→$(AC_7)$	5
RR	Rotate Right	0 0 0 1 1 1 1 0	$(AC_i)\rightarrow(AC_{i-1})$, $(AC_0)\rightarrow(AC_7)$	5
RRL	Rotate Right with Link	0 0 0 1 1 1 1 1	$(AC_i)\rightarrow(AC_{i-1})$, $(AC_0)\rightarrow(CY/L)\rightarrow(AC_7)$	5
	Single-Byte Miscellaneous Instructions	7 6 5 4 3 2 1 0		
HALT	Halt	0 0 0 0 0 0 0 0	Pulse H-flag	8
CCL	Clear Carry/Link	0 0 0 0 0 0 1 0	(CY/L)←0	5
SCL	Set Carry/Link	0 0 0 0 0 0 1 1	(CY/L)←1	5
DINT	Disable Interrupt	0 0 0 0 0 1 0 0	(IE)←0	6
IEN	Enable Interrupt	0 0 0 0 0 1 0 1	(IE)←1	6
CSA	Copy Status to AC	0 0 0 0 0 1 1 0	(AC)←(SR)	5
CAS	Copy AC to Status	0 0 0 0 0 1 1 1	(SR)←(AC)	6
NOP	No Operation	0 0 0 0 1 0 0 0	None	5

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TABLE 3. Instruction Execution Time

INSTRUCTION	READ CYCLES	WRITE CYCLES	TOTAL MICROCYCLES	INSTRUCTION	READ CYCLES	WRITE CYCLES	MICROCYCLES
ADD	3	0	19	JP	2	0	9, 11 for Jump
ADE	1	0	7	JZ	2	0	9, 11 for Jump
ADI	2	0	11	LD	3	0	18
AND	3	0	18	LDE	1	0	6
ANE	1	0	6	LDI	2	0	10
ANI	2	0	10	NOP	1	0	5
CAD	3	0	20	OR	3	0	18
CAE	1	0	8	ORE	1	0	6
CAI	2	0	12	ORI	2	0	10
CAS	1	0	6	RR	1	0	5
CCL	1	0	5	RRL	1	0	5
CSA	1	0	5	SCL	1	0	5
DAD	3	0	23	SIO	1	0	5
DAE	1	0	11	SR	1	0	5
DAI	2	0	15	SRL	1	0	5
DINT	1	0	6	ST	2	1	18
DLD	3	1	22	XAE	1	0	7
DLY	2	0	13 - 131593	XOR	3	0	18
HALT	2	0	8	XPAH	1	0	8
IEN	1	0	6	XPAL	1	0	8
ILD	3	1	22	XPPC	1	0	7
JMP	2	0	11	XRE	1	0	6
JNZ	2	0	9, 11 for Jump	XRI	2	0	10

Note: If slow memory is being used, the appropriate delay should be added for each read or write cycle.

TABLE 4. Symbols and Notations Used to Express Instruction Execution

SYMBOL AND NOTATION	MEANING
AC	8-bit Accumulator.
CY/L	Carry/Link Flag in the Status Register.
data	Signed, 8-bit immediate data field.
disp	Displacement; represents an operand in a nonmemory reference instruction or an address modifier field in a memory reference instruction. It is a signed twos-complement number.
EA	Effective Address as specified by the instruction.
E	Extension Register; provides for temporary storage, variable displacements and separate serial input/output port.
i	Unspecified bit of a register.
IE	Interrupt Enable Flag.
m	Mode bit, used in memory reference instructions. Blank parameter sets m = 0, @ sets m = 1.
OV	Overflow Flag in the Status Register.
PC	Program Counter (Pointer Register 0); during address formation, PC points to the last byte of the instruction being executed.
ptr	Pointer Register (ptr = 0 through 3). The register specified in byte 1 of the instruction.
$ptr_{n:m}$	Pointer register bits; n:m = 7 through 0 or 15 through 8.
SIN	Serial Input pin.
SOUT	Serial Output pin.
SR	8-bit Status Register.
( )	Means "contents of." For example, (EA) is contents of Effective Address.
[ ]	Means optional field in the assembler instruction format.
~	Ones complement of value to right of ~.
→	Means "replaces."
←	Means "is replaced by."
↔	Means "exchange."
@	When used in the operand field of the instruction, sets the mode bit (m) to 1 for auto-incrementing/auto-decrementing indexing.
10^+	Modulo 10 addition.
∧	AND operation.
V	Inclusive-OR operation.
⊻	Exclusive-OR operation.
⩾	Greater than or equal to.
=	Equals.
≠	Does not equal.

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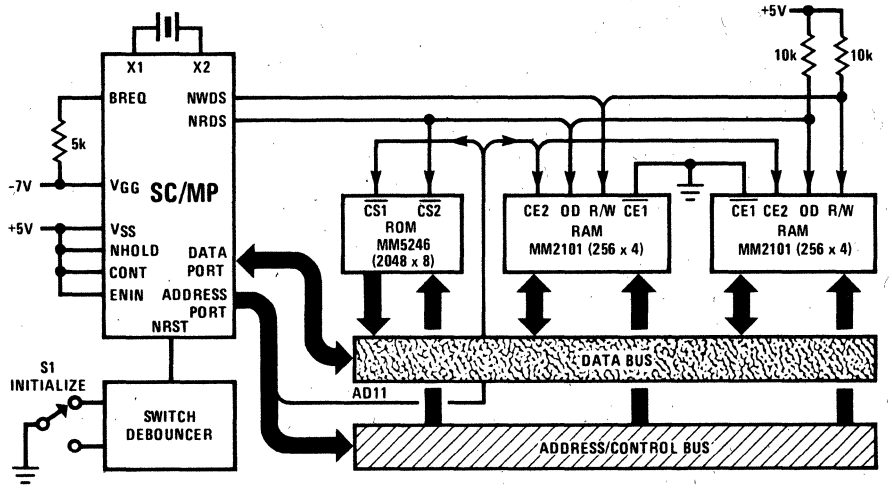
system implementation

Figures 9 through 11 illustrate typical SC/MP system configurations. In figure 9, SC/MP is shown interconnected to three memory devices to form a stand-alone 4-device system that provides 256 words of read/write memory and 2,048 words for program storage. Figure 10 shows SC/MP interconnected to an external controller for Direct Memory Access (DMA) operation, and figure 11 illustrates a multiprocessor application using SC/MP's built-in logic to control bus access.



NOTE: PART NUMBERS ARE SHOWN ONLY FOR INFORMATION PURPOSES. OTHER MEMORY COMPONENTS WITH SUITABLE CHARACTERISTICS CAN BE USED.

FIGURE 9. SC/MP Four-Chip System

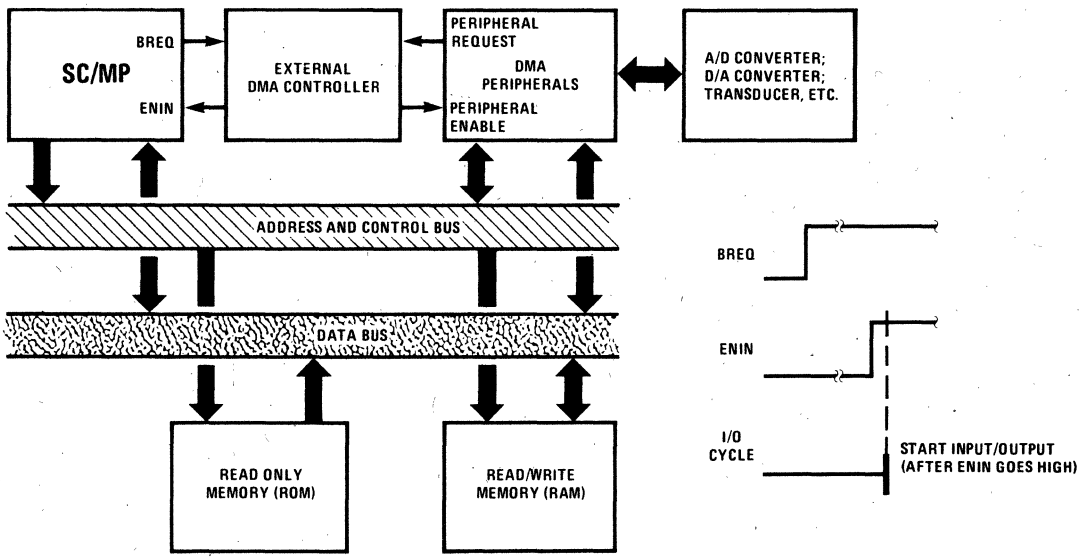


FIGURE 10. SC/MP Interconnected for Direct Memory Access (DMA) Operation

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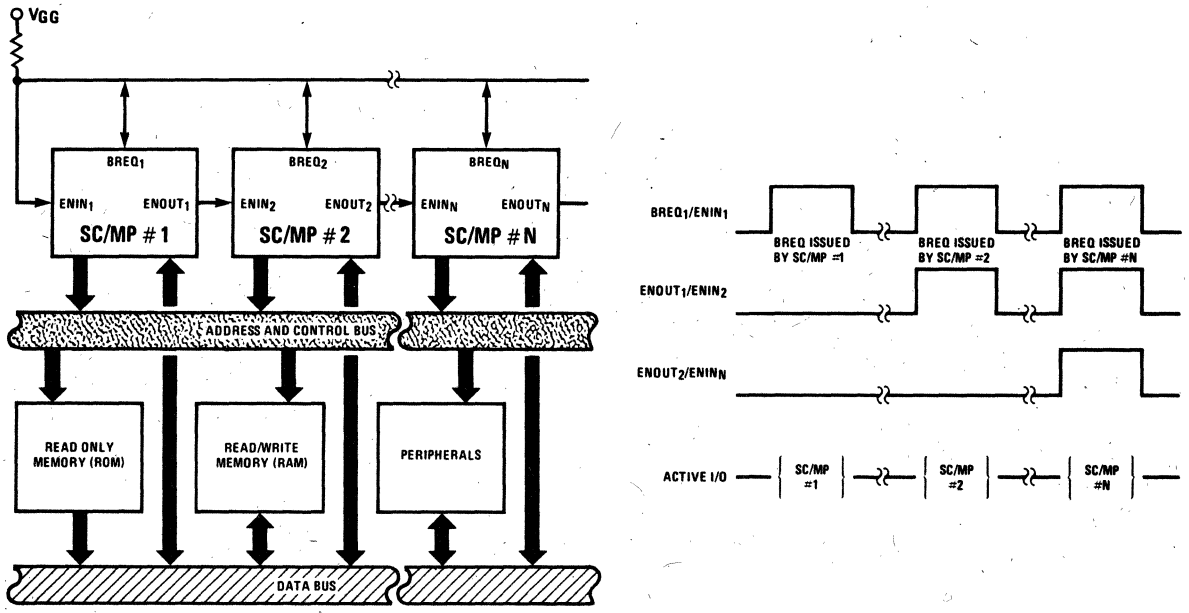
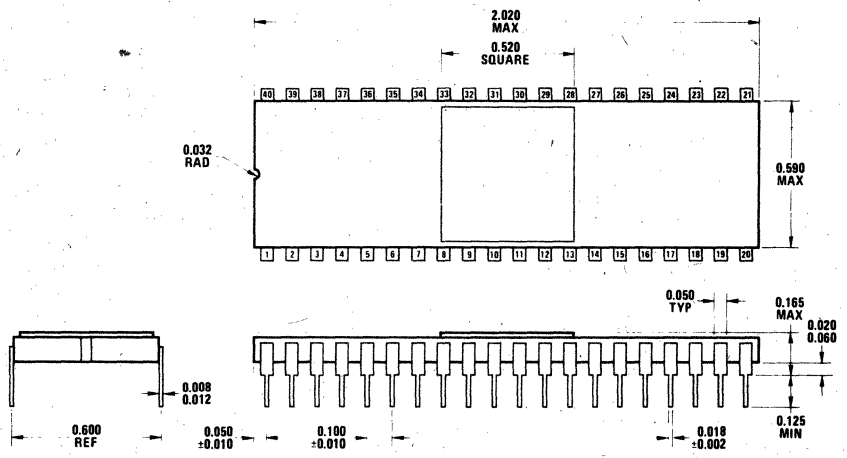


FIGURE 11. Multiprocessor System Using SC/MP Built-in Logic for Bus Control

physical dimensions



ordering information

The SC/MP device may be ordered through the local National Semiconductor sales representative or by contacting our world or international headquarters listed below. The order number is as follows:

ISP-8A/500D

Manufactured under one or more of the following U S patents: 3083262, 3189758, 3231797, 3303356, 3317671, 3323071, 3381071, 3408542, 3421025, 3426423, 3440498, 3518750, 3519897, 3557431, 3560765, 3566218, 3571630, 3575609, 3579059, 3593089, 3597640, 3607469, 3617859, 3631312, 3633052, 3638131, 3648071, 3651565, 3693248

National Semiconductor Corporation
2900 Semiconductor Drive, Santa Clara, California 95051, (408) 732-5000/TWX (910) 339-9240

National Semiconductor GmbH
808 Fuerstenfeldbruck, Industriestrasse 10, West Germany, Tele. (08141) 1371/Telex 27649

National Semiconductor (UK) Ltd
Larkfield Industrial Estate, Greenock, Scotland, Tele. (0475) 33251/Telex 778-632

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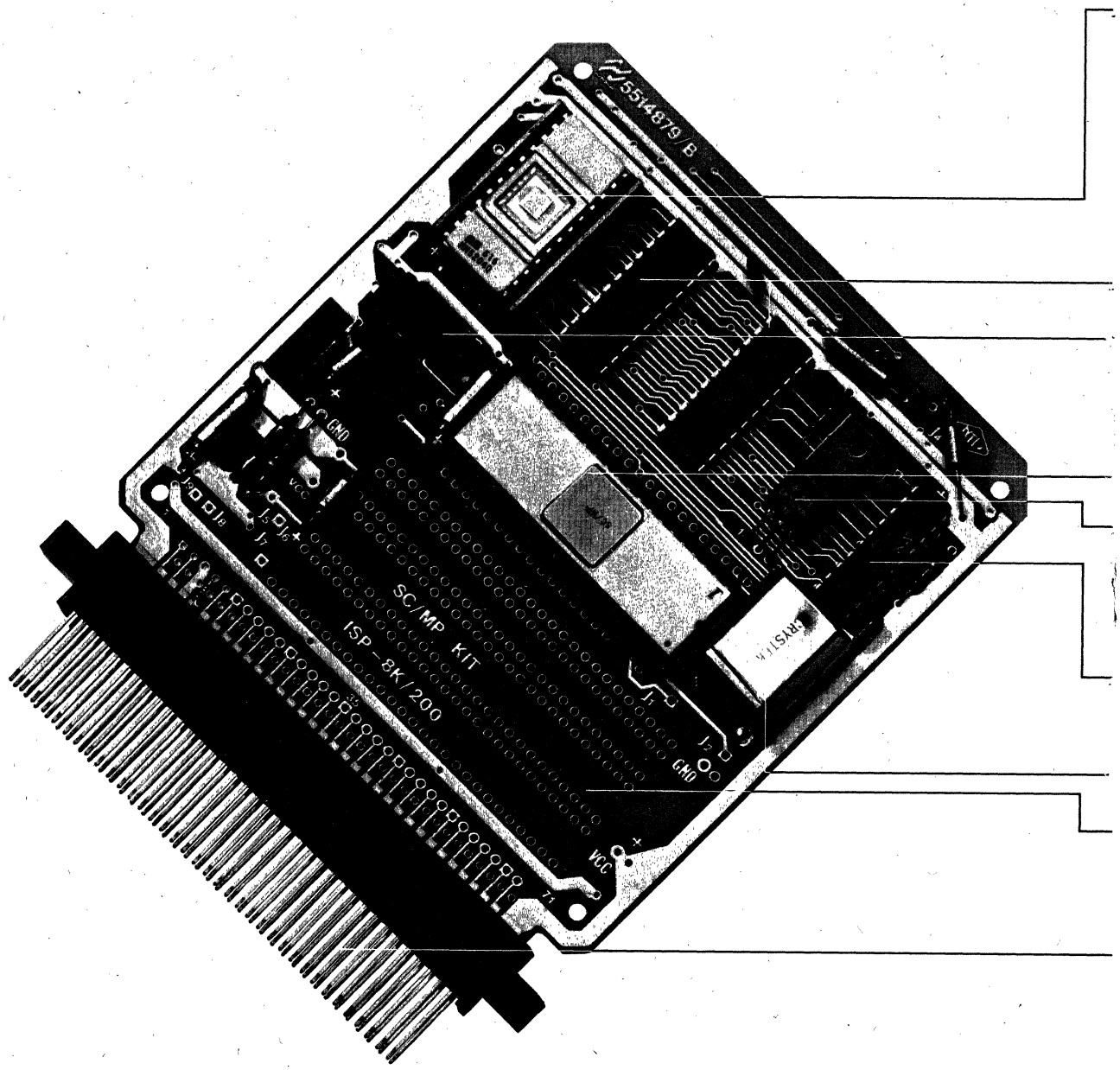
SC/MP Microprocessor Kit

Much more than a bag of parts – the SC/MP Kit includes all integrated circuits, firmware, and discrete components required to quickly build a completely functional microprocessor system. The printed circuit board provides all the component interconnections to simplify assembly and reduce the possibilities of of assembly errors.

Once you've assembled the kit and applied power – you're ready to explore the capabilities of the SC/MP microprocessor. The ROM contains the KITBUG monitor program for your convenience, and you may add other ROMs or PROMs with programs of your choice. KITBUG, a firmware program contained in read-only-memory, lets you enter your own programs directly into read/write memory for the TTY keyboard. Using KITBUG, you can then execute your program and examine the contents of memory and the SC/MP registers to to monitor the performance of your program.

SC/MP's TTL-compatible input/output interface simplifies the connection of your application hardware so that you can easily implement practical, "real-life" test and demonstration circuits. The hardware is controlled by your application programs using SC/MP's control-oriented instruction set.



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1

ROM – 512 bytes (8-bits/byte) of pre-programmed Read-Only-Memory containing KITBUG – a monitor and debugging program to assist in the development of your application programs. KITBUG provides teletypewriter input/output routines and allows examination, modification, and controlled execution of your programs.

2

RAM – 256 bytes of static read/write memory for storage of your application programs. Transfers of data to and from RAM are controlled by SC/MP and KITBUG.

3

Teletype Interface – provides buffer and drive capabilities to implement the 20 milliampere current loop interface to a teletypewriter.

4

SC/MP Microprocessor – a single-chip Central Processing Unit housed in a 40-pin, dual in-line package. Features static operations, forty-six instruction types; single-byte and double-byte, software controlled interrupt structure, built in serial input/output ports; bidirectional 8-bit TRI-STATE® bus, parallel data/port; latched 12-bit TRI-STATE® address port.

5

Voltage Regulator – LM320MP provides a stable, −7 volt supply to the SC/MP microprocessor chip. This eliminates the need for an extra power supply.

6

8-bit Data Buffer – provides the interface between memory and the SC/MP bidirectional data lines.

7

Timing Crystal – provides a 1.000 Megahertz timing signal for the SC/MP microprocessor – the only timing circuitry required.

8

Space is provided on the printed circuit board to allow mounting additional components for your application.

9

Standard 72-pin edge connector simplifies interconnection to external hardware.

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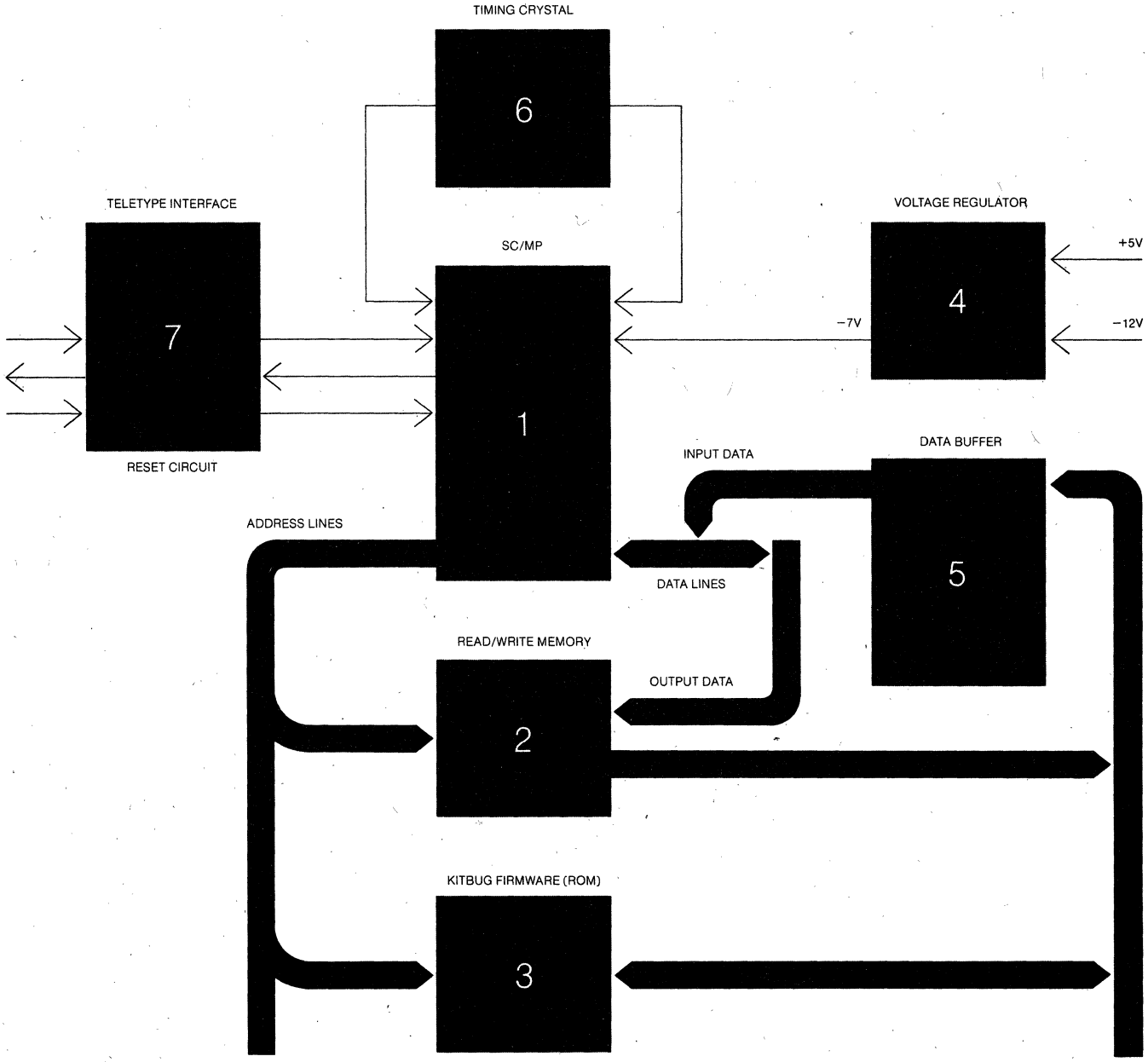
SC/MP Kit Functional Diagram

The SC/MP 1 microprocessor chip generates all control signals required for operation of the Kit. When power is applied (−12v power supplied by user) through regulator 4, SC/MP reads the first instruction in from ROM 3 (Read Only Memory) where the KITBUG monitor firmware is permanently stored. KITBUG then directs the communication between you and SC/MP via the Teletype interface 7. KITBUG lets you enter your own programs into random access memory 2, then transfer control to that program. SC/MP then operates under the direction of your program. SC/MP accesses memory by sending out an address to select a memory location. It then reads the instruction or data back from memory via the data I/O lines. An 8-bit buffer 5 provides the interface between SC/MP and the data bus. All of the system's timing requirements are provided by the 1.000 mhz timing crystal 6.

Order your SC/MP Kit (No. ISP-8k/200) from your local distributor or directly from National Semiconductor, 2900 Semiconductor Drive, Santa Clara, California, 95051.



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SC/MP Low Cost Development System

The SC/MP Low Cost Development System (LCDS) is a simple controller configured to provide maximum flexibility at affordable cost. It provides all the features necessary for development and testing of SC/MP hardware and software designs for a user's applications.

The minimum SC/MP Development System is configured with a SC/MP CPU Card plugged into one of four sockets in a Card Bus on a 10″ x 12″ motherboard. Also on the motherboard are a 16 key, dual-function, hexidecimal keyboard; four function keys; 3 control switches and a 6 digit hexidecimal display.

Control logic, scratchpad memory, and ROM based firmware on the motherboard allow the user to examine and alter the SC/MP registers, examine and alter memory locations, run SC/MP programs in continuous or single instruction mode or operate with an optional Teletype® using SC/MP DEBUG.

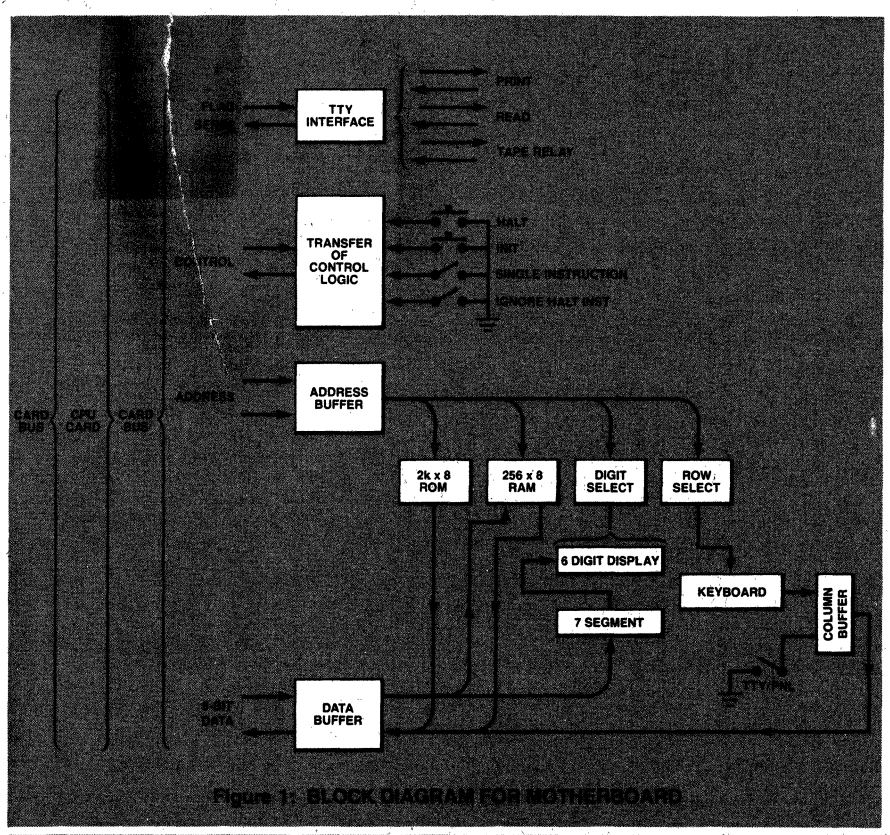

Figure 1: BLOCK DIAGRAM FOR MOTHERBOARD

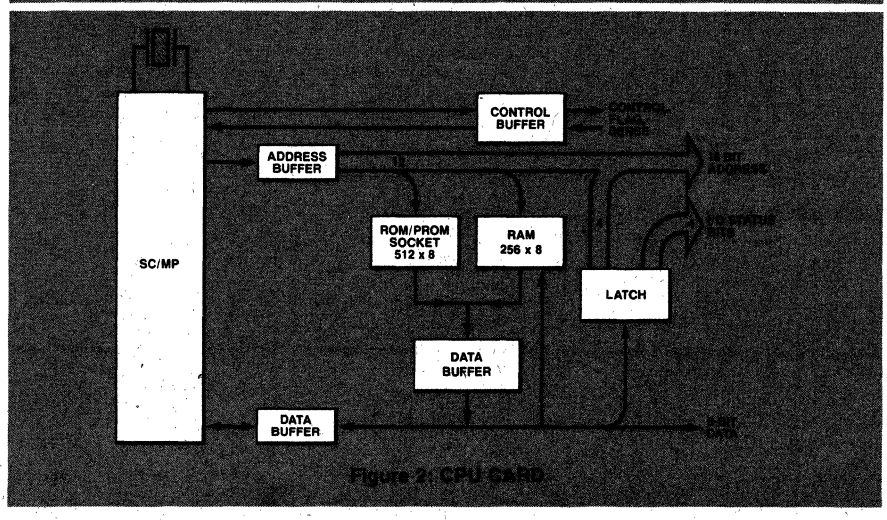

Figure 2: CPU CARD

FEATURES

Salient operating characteristics of the major items comprising the LCDS are as follows.

SC/MP CPU Card

The basic block diagram of the SC/MP CPU card (ISP-8C/100) is shown in Fig. 2. It provides the CPU interface for execution of user-generated application programs and development system resident firmware.

Pre-wired Application System Interface

Four prewired 72-pin edge connector sockets provide a plug-in interface for SC/MP family cards and permit interconnection of additional SC/MP applications hardware via user fabricated cabling. A fifth 72-pin edge connector can be added by the user. In addition, a flat cable connector can be added for coupling to an external card cage.

Interface Logic

Provides control and monitor functions that permit transfer of control between development system resident firmware and user-generated application programs.

Development System Resident Firmware Program

This firmware contains subroutines that permit entry of software debug commands via the programmer's control and display panel, or an optional Teletype.

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Programmer's Control and Display Panel

Provides the following software debug capabilities:

- **Display contents of SC/MP program counter, registers, and accumulator in hexadecimal format.**
- **Alter contents of SC/MP program counter, registers and accumulator.**
- **Display contents of any memory location in hexadecimal format.**
- **Alter contents of any memory location.**
- **Initiate execution of user-generated application program at any memory address.**
- **Select single instruction or normal execution of user generated application program.**
- **Interrupt execution of user-generated application program at any point.**

Teletype Interface-

Provides standard 20-milliampere interface for interconnection of optional Teletype. Expanded software debug capabilities associated with Teletype option include:

- **Print contents of SC/MP program counter, registers, and accumulator**
- **Alter contents of SC/MP program counter, registers, and accumulator**
- **Print contents of any single memory location or selected range of memory locations**
- **Alter contents of any memory location or selected range of memory locations**
- **Set a breakpoint halt in RAM for user-generated application program**
- **Initiate execution of user-generated application program at any memory address**
- **Save application program by punching selected memory range to paper tape**
- **Load development system generated paper tape into memory**
- **Load IMP-16 or FORTRAN Cross Assembler generated paper tape into memory.**

Expanding the SC/MP Low Cost Development System

National Semiconductor offers various cards which may be used in conjunction with the SC/MP LCDS System. The 2K x 8 Read/Write Memory Card (ISP-8C/002) and the 4K x 8 ROM/PROM Card (ISP-8C/004) can be used to provide additional memory for user application or system development.

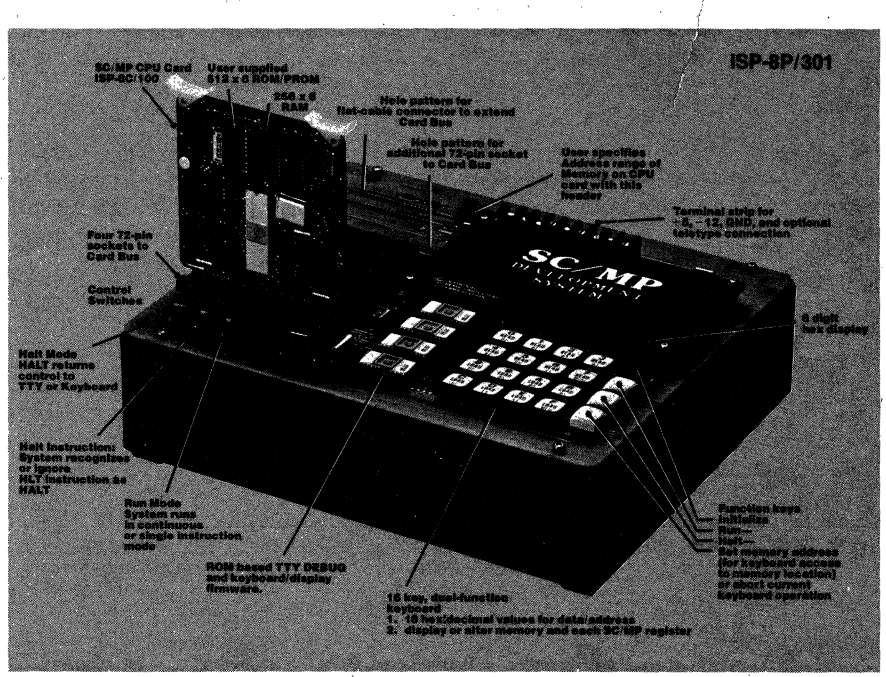
The standard Cards can be plugged into any of the connectors on the Card Bus. The bus is easily expanded by use of flat-cable to external user supplied modules.

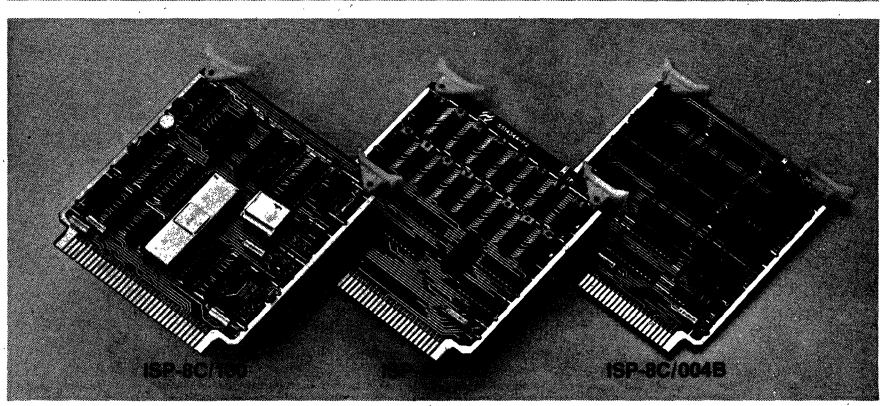
Typical use of the system provides capability to debug user systems with program in RAM, using features of DEBUG such as single instruction or breakpoints. Changes to the program can be made directly from the keyboard or teletype. When the program is running correctly, it can be dumped to paper tape for programming ROM or PROM.

Ordering Information

The SC/MP LCDS and supporting cards may be ordered directly from National Semiconductor or National's franchised distributor near you.

SC/MP LCDS (includes one CPU Card)	**ISP-8P/301**
SC/MP RAM Card (2K x 8)	**ISP-8C/002**
SC/MP ROM/PROM Card (4K x 8) (includes eight 5204 PROMs)	**ISP-8C/004P**
SC/MP ROM/PROM Card (4K x 8) (without PROM Memory)	**ISP-8C/004B**
SC/MP CPU Card	**ISP-8C/100**





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National Semiconductor

SC/MP KEYBOARD KIT

- Low Cost Human Interface
- Handheld Keyboard and Display
- Direct Object Code Program Manipulation
- Simple Processor Control

National's new Keyboard Kit now gives SC/MP Kit users a low-cost input/output capability. This new kit replaces the Teletype* normally required by the SC/MP Kit and allows users to evaluate the SC/MP CPU and to develop a variety of application software.

The heart of SC/MP Keyboard Kit is a ROM firmware package (512 bytes) called SCMPKB. The SCMPKB ROM replaces the "Kit Bug" ROM originally supplied with the SC/MP Kit and allows the effective use of the hexadecimal keyboard, to execute programs, to examine or modify the contents of memory and the SC/MP registers, and to monitor program performance.

There is a hole pattern for additional integrated circuits on the SC/MP Kit PC card. By following the simple instructions in the SC/MP Keyboard Kit users manual, one can add buffers, decoders, drivers, multiplexers, etc. Simply replace the Kit Bug ROM (supplied in the SC/MP Kit) with the new SCMPKB ROM, connect the preassembled Keyboard cable connector to the kit card, and you are ready to go!

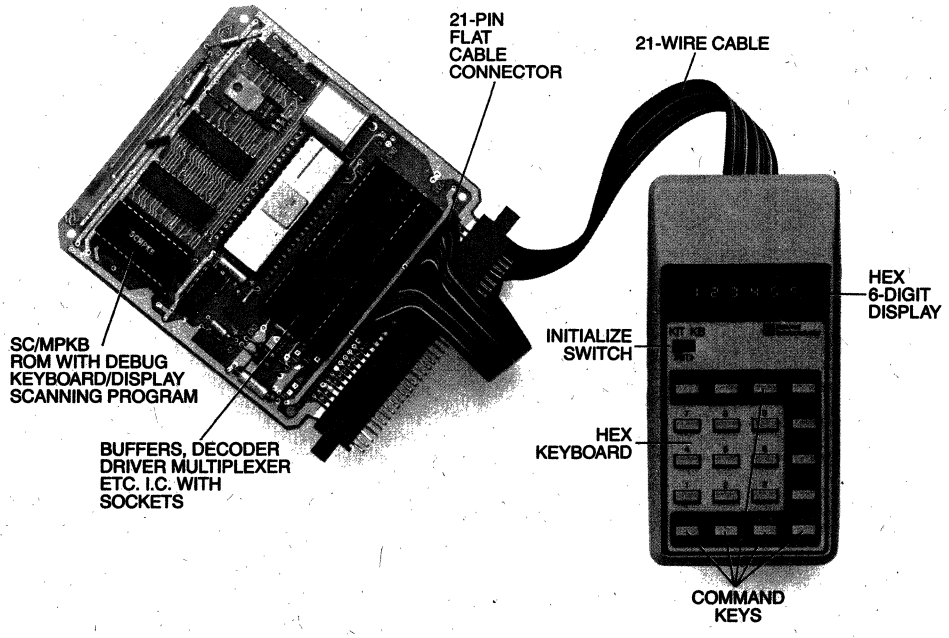
National's Keyboard Kit comes complete with manual, all required integrated circuits, resistors, keyboard display cable connector assembly, wire wrap connectors, precut wires—even a hand-held wire wrap tool.

This is a great kit for engineers and companies who don't have access to a Teletype. It is a low-cost teaching, learning, and developing tool for hobbyists, professors, students, and electronics entrepreneurs of all levels.

The Keyboard Kit is another step in the SC/MP tradition of simple, cost-effective solutions to your microprocessor needs.

To order your SC/MP Keyboard Kit: Call your local National Semiconductor distributor or sales representative. Ask for ISP-8K/400.

*A trademark of Teletype Corp.



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IPC-16A/520D MOS/LSI single chip 16-bit microprocessor (PACE)

user benefits

- Simplified programming
- Simplified I/O design
- Simplified system configurations
- Simplified prototyping

PACE features

- 45 instruction types
- All instruction single-word
- Multiple addressing modes
  - Program-counter relative
  - Base page
  - Indexed
  - Direct and indirect
- Four general-purpose accumulators
- Byte and word processing
- Common memory and peripheral addressing
- Six hardware-vectored priority interrupts
- 10-word on-chip stack
- Four control flag outputs
- Three sense inputs
- Four I/O control strobe signals
- CPU in single 40-pin package supported by single-chip
  - Timing element
  - Transceivers
  - Address latches
  - I/O ports
  - 1k x 16 ROM
- Chip kits
- Application cards
- Development systems
- Full array of software
  - Assemblers
  - Cross assemblers
  - Loaders
  - Editor
  - Debug
  - Diagnostics

block diagram

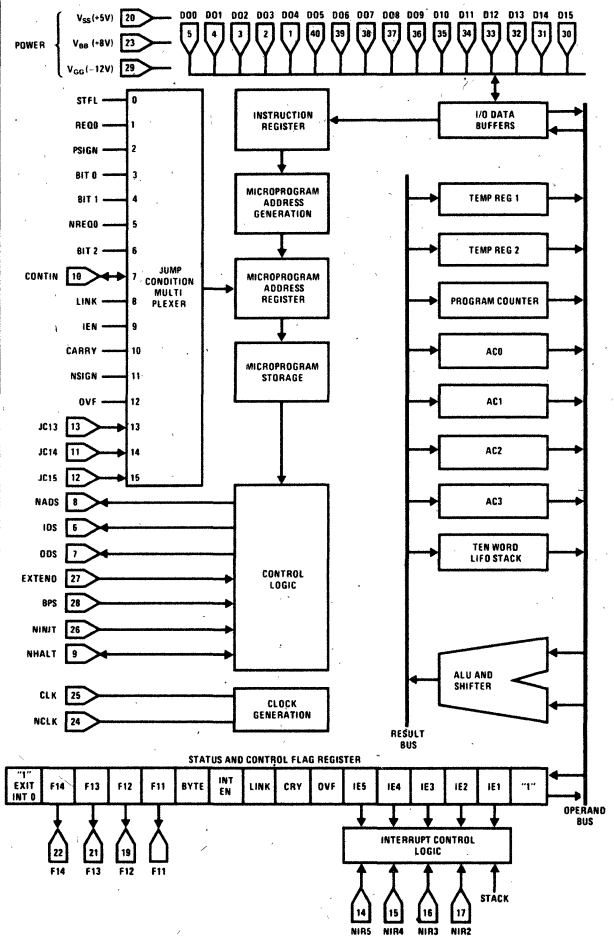

FIGURE 1. PACE Detailed Block Diagram

general description and functional highlights

PACE (Processing and Control Element) is a single-chip, 16-bit microprocessor packaged in a standard, hermetically sealed, 40-pin ceramic dual-in-line package. PACE utilizes silicon gate enhancement mode process technology which ensures high performance, high reliability and high producibility.

PACE is intended for use in applications where the convenience and efficiency of 16-bit word length is desired while maintaining the low cost inherent in single-chip, fixed instruction microprocessors. PACE is a true 16-bit central processor unit: it makes use of 16-bit instruction words and 16-bit data words, and features a powerful, efficient, and flexible set of 45 instructions. All instructions use a single-word, 16-bit format thus reducing memory accesses and program storage requirements. A unique feature of PACE is the ability to operate on both 8- and 16-bit data words: this extends the inherent efficiency and power of a 16-bit processor to 8-bit applications.

The architecture of PACE (shown in *Figure 1*) features a number of resources to minimize system program and read/write storage, increase throughput, and reduce the amount and cost of external support hardware. The principal resources that allow these efficiencies to be achieved include:

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FOUR 16-BIT GENERAL PURPOSE WORKING REGISTERS available to the user reduce the number of memory load and store operations associated with saving temporary and intermediate results in system memory.

AN INDEPENDENT 16-BIT STATUS AND CONTROL FLAG REGISTER automatically and continuously preserves system status. The user may operate on its contents as data, allowing masking, testing and modification of several bit fields simultaneously.

A TEN WORD (16-BIT) LAST-IN, FIRST-OUT (LIFO) STACK inherently decreases response time to interrupts while eliminating both program and read/write system storage overhead associated with storing stack information outside the microprocessor chip.

STACK FULL/STACK EMPTY interrupts are provided to facilitate off-chip stack storage in those applications where additional stack capacity is desirable.

A SIX LEVEL, VECTORED PRIORITY INTERRUPT SYSTEM internal to the chip provides automatic interrupt identification, eliminating both program storage overhead and the time normally required to poll peripherals in order to identify the interrupting device.

THREE SENSE INPUTS AND FOUR CONTROL FLAG OUTPUTS allow the user to respond directly to specific combinations of status present in the microprocessor-based system, thus eliminating costly hardware, program overhead and throughput associated with implementing these functions over the system data bus.

A COMPREHENSIVE SET OF INPUT/OUTPUT CONTROL SIGNALS provided by the internal Control Logic simplifies interfaces to memory and peripherals and allows flexible control of PACE operations.

SINGLE-PHASE TRUE AND COMPLEMENT CLOCK INPUTS are easily generated with a minimum of external components.

PACE interface signal descriptions

The functions of each of the PACE signals are described below. Timing specifications for the signals are provided in the table of electrical characteristics and associated diagrams. Pin assignments are shown in *Figure 2*.

Dual-In-Line Package

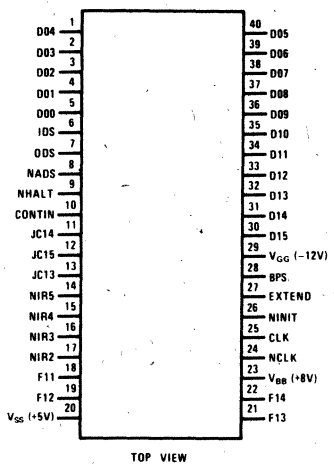

FIGURE 2. PACE Pin Assignments

CLK, NCLK (inputs) – External true and complemented clock inputs.

D00-D15 (input/output) – Data bus lines. Bidirectional MOS data lines used for input and output of data and for output of 16-bit addresses on I/O cycles.

NADS (output) – Address Data Strobe. The negative-true NADS signal is sent out at the beginning of every data input/output cycle and indicates that a memory or peripheral address has been output on the data bus lines. The address is stable on the data bus while the NADS signal is active low.

ODS (output) – Output Data Strobe. The ODS signal indicates to external circuits that the data bus contains valid output data.

IDS (output) – Input Data Strobe. The IDS signal indicates to external devices that PACE is performing a data input cycle. The signal should be used by memory or peripheral devices to gate data onto the PACE data bus lines.

EXTEND (input) – Extended Data Transfer. The EXTEND signal is used by slower memory or peripheral devices to temporarily increase time duration of data input/output transfers. The EXTEND signal should be driven high at the beginning of ODS or IDS signal and held high until output data has been captured or input data is made available to data bus. The EXTEND signal can also be used to suspend input/output operations by applying the signal after the end of ODS or IDS.

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JC13, JC14, JC15 (input) – Jump Conditions 13, 14, and 15. JC13, 14, and 15 are user-specified inputs that can be tested using Branch-On-Condition (BOC) Instructions. If jump condition input specified in BOC Instruction is high, a program branch is effected. The JC13-JC15 signals are useful for testing status of external devices and receiving serial data.

F11, F12, F13, F14 (output) – General-purpose control flag outputs from PACE Status and Control Flags Register. Individual flags may be set by Set Flag Instruction and pulsed or reset by Pulse Flag Instruction. The F11-F14 signals may be used for direct control of system functions or serial data output.

NIR2, NIR3, NIR4, NIR5 (input) – Interrupt Requests 2, 3, 4, and 5. When these negative-true input signals are low for 1 CLK period, minimum, the associated internal Interrupt Request Latch is set if the corresponding interrupt enable has been set by users program. The interrupt will be serviced after completion of current instruction if the Master Interrupt Enable is set. Interrupt Requests are prioritized, with NIR5 having lowest priority.

NHALT (input/output) – Halt. When the negative-true NHALT signal is driven low by external logic, it effects microprocessor stall or Level-0 Interrupt, depending on timing of CONTIN signal. When not controlled by external logic, NHALT is driven low by PACE for 7/8 duty cycle while programmed halt condition exists. Programmed halt is initiated by the Halt Instruction and terminated by pulsing CONTIN line via external logic.

CONTIN (input/output) – Continue. The CONTIN signal is used in input mode to terminate programmed halt, or to exercise microprocessor stall and Level-0 Interrupt, or as a jump-condition input that can be tested using a BOC instruction. In the output mode, CONTIN transmits an interrupt acknowledge pulse to acknowledge CPU response to an active interrupt input.

BPS (input) – Base Page Select. The BPS signal enables one of two base-page addressing schemes to be selected. When BPS is low, first 256 words of memory constitute base page (page zero). When BPS is high, first 128 memory words and last 128 memory words constitute base page.

NINIT (input) – Initialize. While the negative-true NINIT signal is low, PACE operation is suspended, and IDS/ODS signals are set to inactive state. After NINIT completes low-to-high transition, the program counter is set to zero, the internal stack pointer is cleared, and all flags and interrupt enables are set low except Level-0 Interrupt Enable which is set high. All other registers contain arbitary values.

V_{SS}	+5 Volts
V_{GG}	−12 Volts
V_{BB}	V_{SS} +3 Volts (substrate bias)

interrupt system

The PACE microprocessor provides a six level, vectored, priority interrupt structure. This allows automatic identification of an interrupting device's level and allows all devices on an interrupt level to be enabled or disabled as a group, independent of other interrupt levels. An individual interrupt enable is provided in the status register for each level, as shown in *Figure 3*, and a master interrupt enable (IEN) is provided for all 5 lower priority levels as a group. Negative true interrupt request inputs are provided to allow several interrupts to be "wire-ORed" on each input. When an interrupt request occurs, it will set the interrupt request latch if the corresponding interrupt enable is true. The latch will be set by any pulse exceeding one clock period in duration, which is useful for capturing narrow timing or control pulses. If the master interrupt enable (IEN) is true, then an interrupt will be generated. During the interrupt sequence an address is provided by the output of the priority encoder and is used to access the pointer for the highest-priority interrupt request (IR0 is highest priority, IR5 is lowest priority). The pointers are stored in locations 2–7 (see Table 1) for interrupt requests 1–5 and 0, respectively. The pointer specifies the starting address of the interrupt service routine for that particular interrupt level. Before executing the

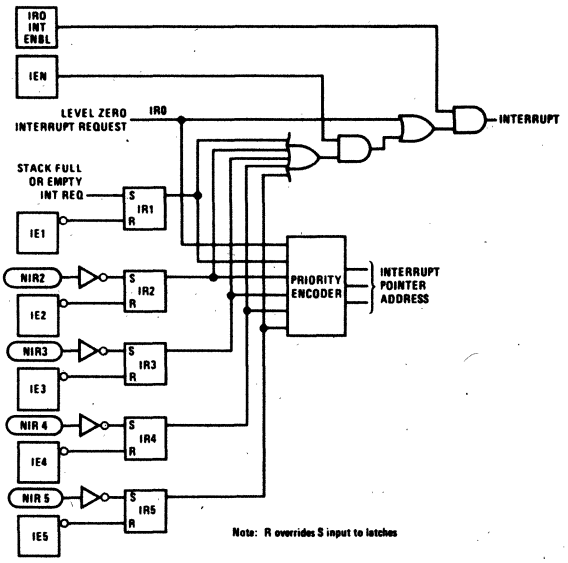

FIGURE 3. Interrupt System

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interrupt service routine, the program counter is pushed on the stack and IEN is set false. The interrupt service routine may set IEN true after turning off the interrupt enable for the level currently being serviced (or resetting the interrupt request). (The interrupt enables may be set and reset using the SFLG and PFLG instructions.)

TABLE 1. Interrupt Pointer Table

8	Int 0 Program
7	Int 0 PC Pointer
6	Int 5 Pointer
5	Int 4 Pointer
4	Int 3 Pointer
3	Int 2 Pointer
2	Int 1 Pointer
1	Not Assigned
Loc 0	Initialization Inst

The non-maskable level zero interrupt (IR0) is an exception to this interrupt procedure. It has a program counter storage location pointer (the program counter is not stored on the stack for this particular interrupt in order to preserve the processor state) which is followed by the level zero interrupt service routine. The IR0 interrupt enable is cleared when a level zero interrupt occurs (IEN is unaffected) and may be set true by setting (non-existent) status flag 15. This allows execution of one more instruction (typically JMP@) to return from the IR0 interrupt routine before another interrupt will be acknowledged. This interrupt level is typically used by the control panel, which then can always interrupt the application program and does not affect system status. Level zero interrupts are generated by exercising the NHALT and CONTIN lines.

instruction summary

The instruction set is divided into eight instruction classes as listed in Table 3. The branch instructions provide the means to transfer control anywhere in the 16-bit addressing space. Conditional branches are effected using the BOC instruction, which allows testing any one of 16 conditions, including status flags, the contents of AC0, and user inputs to the chip. Additional testing capability is provided by the skip instructions, which provide memory or peripheral to register comparisons without altering data. The memory data transfer instructions provide data transfers between the accumulators and memory or peripheral devices. The load with sign extended is provided to convert 8-bit, two's complement data to 16-bit data, allowing 16-bit address modification when the 8-bit data length has been selected.

The memory data operate instructions provide operations between the principal working register (AC0) and memory or peripheral data. This includes both binary and BCD arithmetic instructions. The register data transfer instructions provide a very complete set of transfer possibilities between the accumulators, flag register and stack, and include the capability to load immediate data. Register data operate instructions provice logical and arithmetic operations between any two accumulators. They may be used for address and data modification and to reduce the number of (time consuming) memory references in a program. The shift and rotate instructions allow 8 different operations which are useful for multiply, divide, bit scanning and serial input-output operations. The miscellaneous instructions include the capability to set or reset (pulse) any of the 16 bits of the status flag register individually.

The power of the instruction set is further enhanced by a flexible memory addressing scheme that provides three floating memory pages and one fixed page of 256 words each. Instructions which use both direct and indirect memory addressing are included in the instruction set. Three modes of direct memory addressing are available: base page, program counter relative, and index register relative. The mode of addressing is specified by the XR field of the instruction shown in the "Instruction Format" column of Table 3. Table 2 summarizes the direct addressing modes available.

TABLE 2. Direct Addressing Modes

XR Field	Addressing Mode	Effective Address
00	Base Page	EA = disp
01	Program Counter Relative	EA = disp + (PC)
10	AC2 Relative (indexed)	EA = disp + (AC2)
11	AC3 Relative (indexed)	EA = disp + (AC3)

Note 1: For base page addressing, disp is positive and in the range of 000 to 255 if BPS = 0, and is a signed number in the range of −128 to +127 if BPS = 1.
Note 2: For relative addressing, disp has a range of −128 to +127.

Indirect addressing consists of first establishing an address in the same fashion as with direct addressing [by either the base page, relative to PC, or indexed (relative to AC2 or AC3) mode]. The 16-bit contents of the memory location at this address is then used as the address of the operand, allowing any memory location to be addressed.

drivers and receivers

Equivalent circuits for PACE drivers and receivers are shown in *Figure 4*. All inputs have static charge protection circuits consisting of an RC filter and voltage clamp. These devices should still be handled with care, as the protection circuits can be destroyed by excessive static charge. Pullup transistors on several inputs are turned on during one of the eight internal clock phases. In the case of bidirectional signals, the output driver transistors also serve as input pullup transistors.

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TABLE 3. PACE Instruction Summary

	Mnemonic	Meaning	Operation	Maximum Execution Time (Note)	Instruction Format
1.	**Branch Instructions**				
	BOC	Branch On Condition (Table 4)	(PC) ← (PC) + disp if cc true	$5M + E_R + 1M$ if branch	0 1 0 0 | cc | disp
	JMP	Jump	(PC) ← EA	$4M + E_R$	0 0 0 1 1 0 | xr
	JMP@	Jump Indirect	(PC) ← (EA)	$4M + 2E_R$	1 0 0 1 1 0
	JSR	Jump To Subroutine	(STK) ← (PC), (PC) ← EA	$5M + E_R$	0 0 0 1 0 1
	JSR@	Jump To Subroutine Indirect	(STK) ← (PC), (PC) ← (EA)	$5M + 2E_R$	1 0 0 1 0 1
	RTS	Return from Subroutine	(PC) ← (STK) + disp	$5M + E_R$	1 0 0 0 0 0 | 0 0
	RTI	Return from Interrupt	(PC) ← (STK) + disp, IEN = 1	$6M + E_R$	0 1 1 1 1 1 | 0 0
2.	**Skip Instructions**				
	SKNE	Skip if Not Equal	If (ACr) ≠ (EA), (PC) ← (PC) + 1	$5M + 2E_R + 1M$ if skip	1 1 1 1 r | xr | disp
	SKG	Skip if Greater	If (AC0) > (EA), (PC) ← (PC) + 1	$7M + 2E_R + 1M$ if skip	1 0 0 1 1 1
	SKAZ	Skip if And is Zero	If [(AC0) ∧ (EA)] = 0, (PC) ← (PC) + 1	$5M + 2E_R + 1M$ if skip	1 0 1 1 1 0
	ISZ	Increment and Skip if Zero	(EA) ← (EA) + 1, if (EA) = 0, (PC) ← (PC) + 1	$7M + 2E_R + E_W + 1M$ if skip	1 0 0 0 1 1
	DSZ	Decrement and Skip if Zero	(EA) ← (EA) − 1, if (EA) = 0, (PC) ← (PC) + 1	$7M + 2E_R + E_W + 1M$ if skip	1 0 1 0 1 1
	AISZ	Add Immediate, Skip if Zero	(ACr) ← (ACr) + disp, if (ACr) = 0, (PC) ← (PC) + 1	$5M + E_R + 1M$ if skip	0 1 1 1 1 0 | r
3.	**Memory Data Transfer Instructions**				
	LD	Load	(ACr) ← (EA)	$4M + 2E_R$	1 1 0 0 r | xr | disp
	LD@	Load Indirect	(AC0) ← ((EA))	$5M + 3E_R$	1 0 1 0 0 0
	ST	Store	(EA) ← (ACr)	$4M + E_R + E_W$	1 1 0 1 r
	ST@	Store Indirect	((EA)) ← (AC0)	$4M + 2E_R + E_W$	1 0 1 1 0 0
	LSEX	Load With Sign Extended	(AC0) ← (EA) bit 7 extended	$4M + 2E_R$	1 0 1 1 1 1
4.	**Memory Data Operate Instructions**				
	AND	And	(AC0) ← (AC0) ∧ (EA)	$4M + 2E_R$	1 0 1 0 1 0 | xr | disp
	OR	Or	(AC0) ← (AC0) ∨ (EA)	$4M + 2E_R$	1 0 1 0 0 1
	ADD	Add	(ACr) ← (ACr) + (EA), OV, CY	$4M + 2E_R$	1 1 1 0 r
	SUBB	Subtract with Borrow	(AC0) ← (AC0) + ~ (EA) + (CY), OV, CY	$4M + 2E_R$	1 0 0 1 0 0
	DECA	Decimal Add	(AC0) ← (AC0) $+_{10}$ (EA) $+_{10}$ (CY), OV, CY	$7M + 2E_R$	1 0 0 0 1 0
5.	**Register Data Transfer Instructions**				
	LI	Load Immediate	(ACr) ← disp	$4M + E_R$	0 1 0 1 0 0 | r | disp
	RCPY	Register Copy	(ACdr) ← (ACsr)	$4M + E_R$	0 1 0 1 1 1 | dr | sr | 000 000
	RXCH	Register Exchange	(ACdr) ← (ACsr), (ACsr) ← (ACdr)	$6M + E_R$	0 1 1 0 1 1 | dr | sr
	XCHRS	Exchange Register and Stack	(STK) ← (ACr), (ACr) ← (STK)	$6M + E_R$	0 0 0 1 1 1 | r | 0 0
	CFR	Copy Flags Into Register	(ACr) ← (FR)	$4M + E_R$	0 0 0 0 0 1
	CRF	Copy Register Into Flags	(FR) ← (ACr)	$4M + E_R$	0 0 0 0 1 0
	PUSH	Push Register Onto Stack	(STK) ← (ACr)	$4M + E_R$	0 1 1 0 0 0
	PULL	Pull Stack Into Register	(ACr) ← (STK)	$4M + E_R$	0 1 1 0 0 1
	PUSHF	Push Flags Onto Stack	(STK) ← (FR)	$4M + E_R$	0 0 0 0 1 1 | 0 0
	PULLF	Pull Stack Into Flags	(FR) ← (STK)	$4M + E_R$	0 0 0 1 0 0 | 0 0
6.	**Register Data Operate Instructions**				
	RADD	Register Add	(ACdr) ← (ACdr) + (ACsr), OV, CY	$4M + E_R$	0 1 1 0 1 0 | dr | sr | 000 000
	RADC	Register Add With Carry	(ACdr) ← (ACdr) + (ACsr) + (CY), OV, CY	$4M + E_R$	0 1 1 1 0 1
	RAND	Register And	(ACdr) ← (ACdr) ∧ (ACsr)	$4M + E_R$	0 1 0 1 0 1
	RXOR	Register Exclusive OR	(ACdr) ← (ACdr) ⊻ (ACsr)	$4M + E_R$	0 1 0 1 1 0
	CAI	Complement and Add Immediate	(ACr) ← ~ (ACr) + disp	$5M + E_R$	0 1 1 1 0 0 | r | disp
7.	**Shift And Rotate Instructions**				
	SHL	Shift Left	(ACr) ← (ACr) shifted left n places, w/wo link	$(5 + 3n)\ M + E_R$, n = 1 – 127; $6M + E_R$, n = 0	0 0 1 0 1 0 | r | n | ℓ
	SHR	Shift Right	(ACr) ← (ACr) shifted right n places, w/wo link		0 0 1 0 1 1
	ROL	Rotate Left	(ACr) ← (ACr) rotated left n places, w/wo link		0 0 1 0 0 0
	ROR	Rotate Right	(ACr) ← (ACr) rotated right n places, w/wo link		0 0 1 0 0 1
8.	**Miscellaneous Instructions**				
	HALT	Halt	Halt		0 0 0 0 0 0 | 0 0 | 0 | 0000000
	SFLG	Set Flag (Table 5)	$(FR)_{fc} \leftarrow 1$	$5M + E_R$	0 0 1 1 | fc | 1
	PFLG	Pulse Flag (Table 5)	$(FR)_{fc} \leftarrow 1$, $(FR)_{fc} \leftarrow 0$	$6M + E_R$	0 0 1 1 | fc | 0

Note: M = Machine cycle time = 4 clock periods
n = number of shifts
E_R = Extend time for read cycle
E_W = Extend time for write cycle
External interrupt response time is $7M + E_R$ plus time to finish current instruction.

TABLE 4. Branch Conditions

Number	Mnemonic	Condition
0	STFL	Stack full
1	REQ0	(AC0) equal to zero(1)
2	PSIGN	(AC0) has positive sign(2)
3	BIT 0	Bit 0 of AC0 true
4	BIT 1	Bit 1 of AC0 true
5	NREQ0	(AC0) is non-zero(1)
6	BIT 2	Bit 2 AC0 is true
7	CONTIN	CONTIN (continue) input is true
8	LINK	LINK is true
9	IEN	IEN is true
10	CARRY	CARRY is true
11	NSIGN	(AC0) has negative sign(2)
12	OVF	OVF is true
13	JC13	JC13 input is true
14	JC14	JC14 input is true
15	JC15	JC15 input is true

Note 1: If the selected data length is 8 bits, only bits 0-7 of AC0 are tested.
Note 2: Bit 7 is the sign bit (instead of bit 15) if the selected data length is 8 bits.

TABLE 5. Status and Control Flags

Register Bit	Flag Name	Function
0	"1"	Not used—always logic 1
1	IE1	Interrupt Enable Level 1
2	IE2	Interrupt Enable Level 2
3	IE3	Interrupt Enable Level 3
4	IE4	Interrupt Enable Level 4
5	IE5	Interrupt Enable Level 5
6	OVF	Overflow
7	CRY	Carry
8	LINK	Link
9	IEN	Master Interrupt Enable
10	BYTE	8-bit data length
11	F11	Flag 11
12	F12	Flag 12
13	F13	Flag 13
14	F14	Flag 14
15	"1"	Always logic 1, set for Interrupt 0 exit

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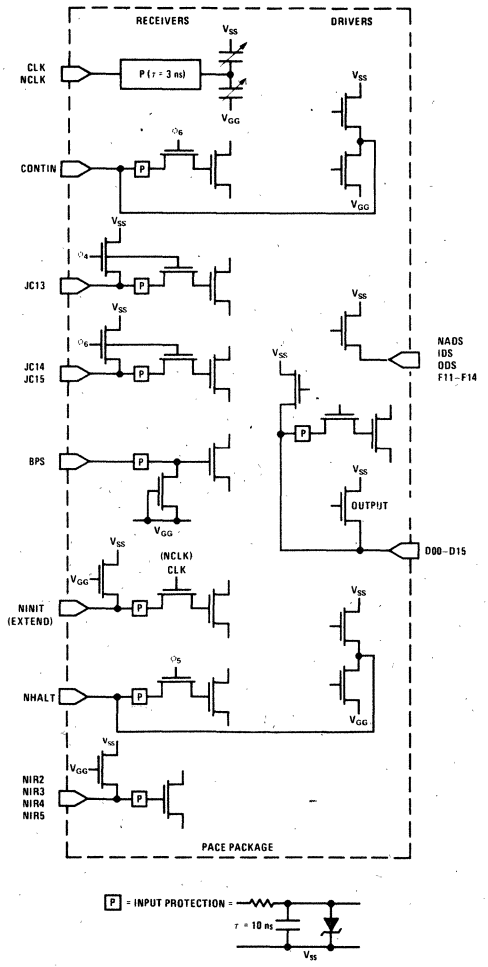
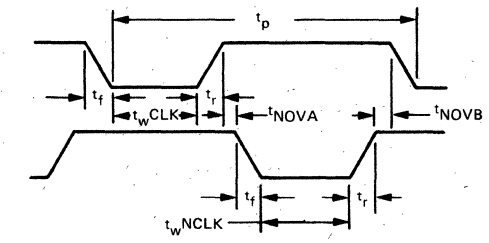


FIGURE 4. PACE Driver and Receiver Equivalent Circuits

external clock timing

PACE requires non-overlapping true and complemented clock inputs as shown in *Figure 5*. Refer to Electrical Characteristics for timing specifications.



where:
t_p = CLOCK PERIOD
$t_{NOVA} = t_{NOVB}$ = CLOCK NONOVERLAP
$t_{WCLK} = t_{WNCLK}$ = CLOCK WIDTH

FIGURE 5. External Clock Timing

initialization

The PACE control circuitry may be initialized at any time by use of the NINIT input signal. The effects of the NINIT signal are described under "PACE Signal Descriptions." The NINIT signal should always be used to initialize the processor after applying power. The minimum pulse width for NINIT is 8 clock periods (see *Figure 6*). The PACE data strobes (NADS, ODS, IDS) are inactive for 16 clock periods after the trailing edge of the NINIT Signal. After the 16 clock periods, the first NADS signal occurs and the first instruction is accessed from memory location zero.

Note: If the NINIT signal is held low while clocks and/or power are first being applied, the NADS and NHALT outputs may have an undefined state for 8 clock periods after the trailing edge of NINIT.

data input/output operations

All data transfers between PACE and external memories or peripheral devices take place over the 16 data lines. These transfers are synchronized by the NADS, IDS, ODS and EXTEND signals. Timing for address data output is shown in *Figure 7*. Where signal timing is referenced to clocks, the reference is to valid logic "1" or logic "0" clock levels. Cross-hatched areas indicate uncertainty of output transitions or "don't care" (optional) states for data inputs. Address data becomes valid one clock phase prior to the Address Data Strobe (NADS) and remains valid for one clock phase afterwards. Typically, NADS will be used to strobe the address data into a latch, either internal or external to the memory chips, or to clock decoded peripheral addresses into a flip-flop.

The PACE address output drivers assume a high impedance state during the data input interval as shown in *Figure 7*. The IDS signal may be used to disable the output sense amplifiers and enable TRI-STATE® input buffers. Increased power supply current may occur during the transition period of the TRI-STATE enable signal, when several devices may be simultaneously enabled. Therefore, good power and ground layout and bypass filtering practice should be observed. The data lines must be driven to valid input data logic levels by the end of IDS. TTL devices will actively drive the input to an intermediate level of $V_{SS} - 2.35V$ and the transition will be completed by a combination of the on-chip pullup transistor and the (reduced) TTL output drive current. Typically, this data input timing will allow operation of the microprocessor in a system at maximum speed if the access time of the system memory is less than 2 clock periods. For memories with longer access times the clock frequency may be reduced or the I/O cycle extend feature may be used, as described below.

Data output timing is shown in *Figure 8*. Output data becomes valid at the leading edge of ODS and remains valid for one clock period following the trailing edge. The Output Data Strobe is typically used as a read-write signal for memory and an output data latch strobe for peripheral interfaces.

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For systems utilizing memories with access times greater than 2 clock periods it may be desirable to use the EXTEND input to lengthen the I/O cycle by multiples of the clock period. Timing for this is shown in *Figure 9*. In the case of either input or output operations, the extend should be brought true prior to the end of internal phase 6. The timing shown in *Figure 9* will provide the minimum extend of one clock period. Holding EXTEND true for n additional clock periods longer will cause an extension of n + 1 clock periods.

In DMA or multiprocessor systems it may be desirable to prevent I/O operations by PACE when the bus is in use by another device. This may be done by using the EXTEND signal immediately following an IDS or ODS as shown in *Figure 10*. Alternatively, the extend timing of *Figure 9* may be used, as the extend function occurs independent of whether there is an I/O operation, that is, whenever the internal clock phase 6 occurs.

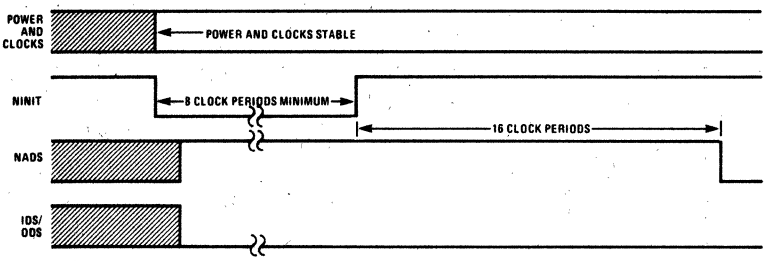
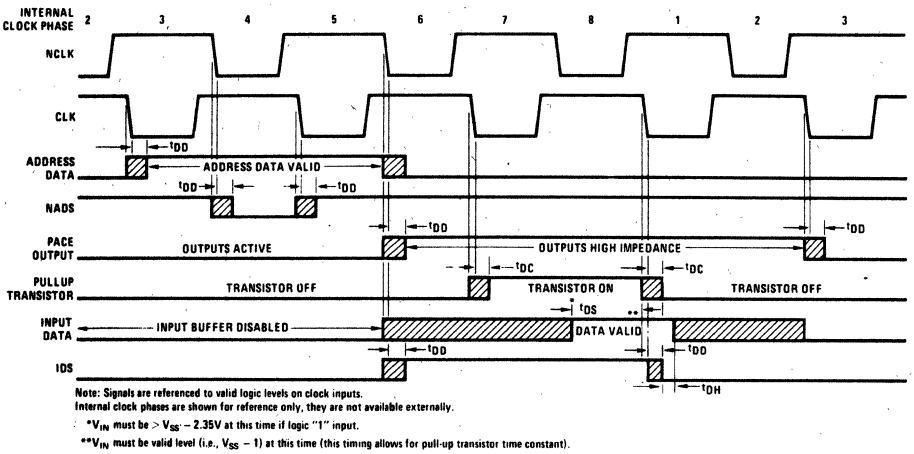


FIGURE 6. Initialization Timing



Note: Signals are referenced to valid logic levels on clock inputs.
Internal clock phases are shown for reference only, they are not available externally.

*V_{IN} must be $> V_{SS} - 2.35V$ at this time if logic "1" input.

**V_{IN} must be valid level (i.e., $V_{SS} - 1$) at this time (this timing allows for pull-up transistor time constant).

Figure 7. Address Output and Data Input Timing

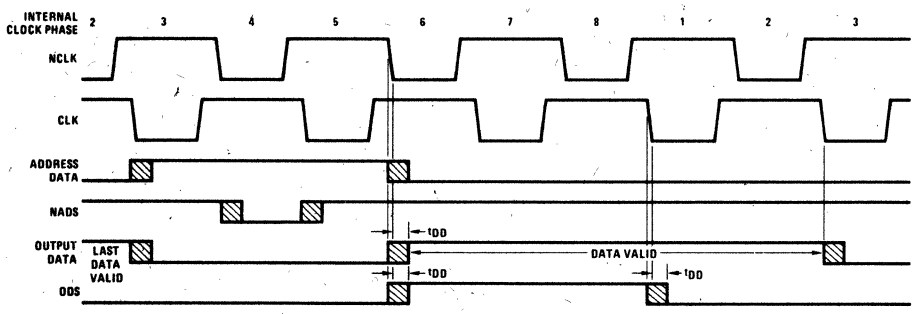


FIGURE 8. Data Output Timing

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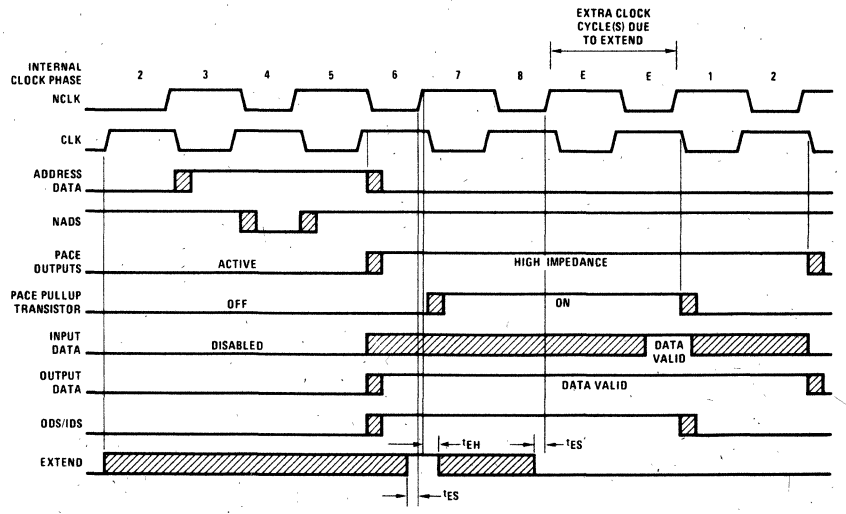

FIGURE 9. Extend I/O Signal Timing

absolute maximum ratings

All Input or Output Voltages with Respect to Most Positive Supply Voltage (V_{BB})	+0.3V to −21.5V	Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	0°C to +70°C	Lead Temperature (Soldering, 10 seconds)	300°C

electrical characteristics (T_A = 0°C to +70°C, V_{SS} = +5V ±5%, V_{GG} = −12V ±5%, V_{BB} = V_{SS} + 3V ±0.5V)

PARAMETER	CONDITIONS	MIN	MAX	UNITS
OUTPUT SPECIFICATIONS				
D00–D15, F11–F14, ODS, IDS, NADS (These are open drain outputs which may be used to drive DS3608 sense amplifiers, or may be used with pull-down resistors to provide a voltage output.)				
Logic "1" Output Current (Except F11–F14)	V_{OUT} = 2.4V	−1.0	−5.0	mA
Logic "1" Output Current, F11–F14 (Note 7)	V_{OUT} = 2.4V	−0.7	−5.0	mA
Logic "0" Output Current	$V_{GG} \leqslant V_{OUT} \leqslant V_{SS}$		±10	μA
NHALT, CONTIN (Low Power TTL Output.)				
Logic "1" Output Voltage	I_{OUT} = −650μA	2.4		V
Logic "0" Output Voltage	I_{OUT} = 300μA		0.4	V
INPUT SPECIFICATIONS				
D00–D15, NIR2–NIR5, EXTEND, JC13–JC15, CONTIN, NINIT, NHALT (These are TTL compatible inputs.) (Note 2)				
Logic "1" Input Voltage		V_{SS}−1	V_{SS}+0.3	V
Logic "0" Input Voltage		V_{SS}−7	V_{SS}−4	V
Pullup Transistor "ON" Resistance (D00–D15) (Note 3)	V_{IN} = V_{SS}−1V		7	kΩ
Pullup Transistor "ON" Resistance (all others)	V_{IN} = V_{SS}−1V		5	kΩ
Logic "0" Input Current (D00–D15)	V_{IN} = 0.4		−1.8	mA
Logic "0" Input Current (NHALT, CONTIN)	V_{IN} = 0.4		−12	mA
Logic "0" Input Current (all others)	V_{IN} = 0.4		−3.6	mA
Capacitance, Input and Output (except clocks)	V_{IN} = V_{SS}, f_T = 500 kHz		20	pF
BPS (This is a MOS Level Input.) (Note 4)				
Logic "1" Input Voltage		V_{SS}−1	V_{SS}+0.3	V
Logic "0" Input Voltage		V_{GG}	V_{SS}−7	V
Logic "1" Input Current	V_{IN} = V_{SS}−1V		100	μA
CLK, NCLK (These are MOS Clock Inputs)				
Clock "1" Voltage (Note 5)		V_{SS}−1	V_{SS}+0.3	V
Clock "0" Voltage		V_{GG}	V_{GG}+1	V
Input Capacitance (Note 6)		30	150	pF
Bias Supply Current	V_{BB} = V_{SS} +3.0V		100	μA
V_{GG} Supply Current	t_p = .65μs, T_A = 25°C		40	mA
V_{SS} Supply Current	t_p = .65μs, T_A = 25°C		85	mA

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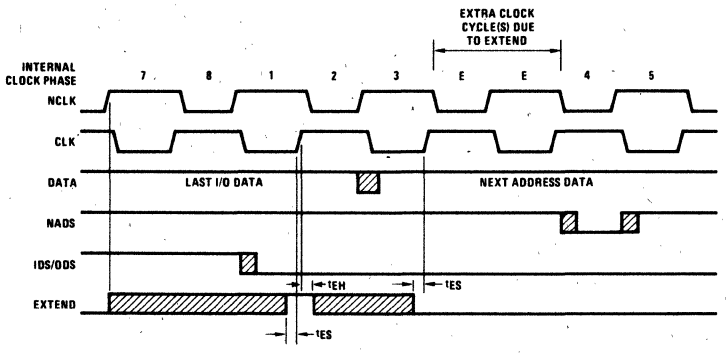

FIGURE 10. Suspend I/O Signal Timing

TIMING SPECIFICATIONS (See *Figures 5 to 10* for additional timing information.)

CLK, NCLK (See *Figure 5*) (Referenced to 10% and 90% Amplitude)				
Rise and Fall Time (t_r, t_f)		10	50	ns
Clock Width ($t_{W\,CLK}$, $t_{W\,NCLK}$)		300	375	ns
Clock Non-Overlap (t_{NOVA}, t_{NOVB})		5		ns
Clock Period (t_p)		.65	.8	μs
EXTEND				
Individual Extend Duration			2	μs
Extend Setup Time (t_{ES}) (Note 10)		100		ns
Extend Hold Time (t_{EH}) (Note 13)		20		ns
Propagation Delay (t_{DD})				
NHALT, CONTIN (Note 9)	C_L = 20 pF		200	ns
NADS, IDS, ODS, D00–D15 (Note 8)	V_{OUT} = 2.4V		100	ns
D00–D15				
Input Setup Time (t_{DS}) (Note 11)		200		ns
Hold Time (t_{DH}) (Note 12)		0		ns
Turn-on or Turn-off Time of Pullup Transistor (t_{DC}) (Note 13)		150		ns
F11–F14 Pulse Flag (PFLG) Pulse Width		$4t_p$ −300	$4t_p$ +300	ns
NINIT Initialization Pulse Width		8		clock periods
NIR2–NIR5 Input Pulse Width to Set Latch		1		clock periods

Note 1: Maximum ratings indicate limits beyond which permanent damage may occur. Continuous operation at these limits is not intended and should be limited to those conditions specified under dc electrical characteristics.
Note 2: Pullup transistor provided on chip (See *Figure 4*.)
Note 3: Pullup transistors on JC13, JC14, JC15 are turned on one out of 8 clock intervals. Pullup transistors on D00–D15 are turned on during last clock period of Input Data Strobe (IDS). Other pullup transistors are on continuously when in data input mode.
Note 4: Pulldown transistor provided on chip.
Note 5: Clamp diodes and series damping resistors may be required to prevent clock overshoot.
Note 6: Capacitance is not constant and varies with clock voltage and internal state of processor.
Note 7: For $V_{SS} \geq V_{OUT} \geq 2.0V$ output current is a linear function of V_{OUT}.
Note 8: Delay measured from valid logic level on clock edge initiating change to valid current output level
Note 9: Delay measured from valid logic level on clock edge initiating change to valid voltage output level.
Note 10: With respect to rising edge of NCLK. (See *Figure 9* and *10*.)
Note 11: With respect to falling edge of CLK. (See *Figure 7*.)
Note 12: With respect to the valid "0" level on the falling edge of Input Data Strobe (IDS). (See *Figure 7*.)
Note 13: With respect to valid logic level of appropriate clock.

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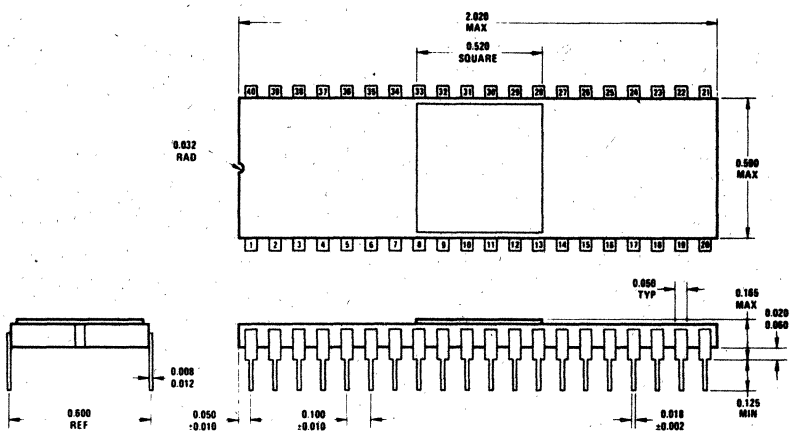
physical dimensions



Cavity Dual-In-Line Package (D)
Order Number IPC-16A/520D

Manufactured under one or more of the following U.S. patents: 3083262, 3189758, 3231797, 3303356, 3317671, 3323071, 3381071, 3408542, 3421025, 3426423, 3440498, 3518750, 3519897, 3557431, 3560765, 3566218, 3571630, 3575609, 3579059, 3593069, 3597640, 3607469, 3617859, 3631312, 3633052, 3638131, 3648071, 3651565, 3693248.

National Semiconductor Corporation
2900 Semiconductor Drive, Santa Clara, California 95051, (408) 737-5000/TWX (910) 339-9240
National Semiconductor GmbH
808 Fuerstenfeldbruck, Industriestrasse 10, West Germany, Tele. (08141) 1371/Telex 05-27649
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National Semiconductor

PACE LOW COST DEVELOPMENT SYSTEM

- > Simplified Interface and Machine Code Development
- > Excellent Training and Learning Tool
- > Low Cost
- > Integral Hex Display
- > Integral Keypad
- > Selectable Baud Rate Serial Interface

The PACE Low Cost Development System from National Semiconductor is a fast and efficient vehicle for developing a working microprocessor application system. PACE LCDS features an ease of hardware and software access that facilitates interface and machine code development.

The system contains its own 20-key keypad. Using this, the designer can directly enter data, instructions, and control commands. And on the integral 6-digit hex LED display the designer can easily examine register and memory contents.

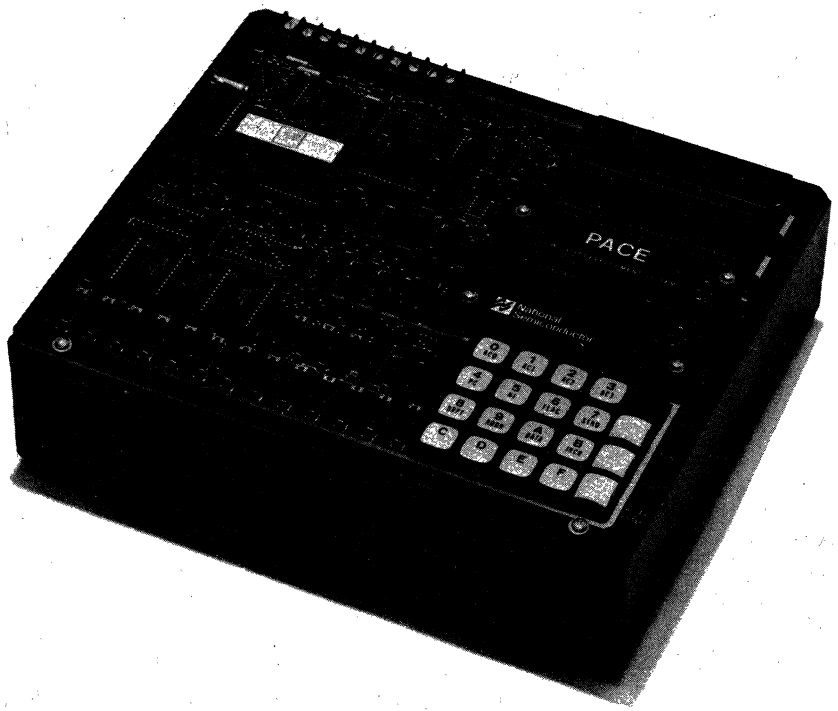
For versatility, the LCDS provides strap selectable baud rates: either RS232 or 20 ma current loop serial interfaces. This allows use of a variety of common input/output peripherals, including Teletype, CRTs, and other keyboard devices.

The designer builds application routines or subroutines by entering code directly through a keyboard. He may operate in a single-step or continuous mode with set break points. Alternatively, he may use a Teletype to load paper tape in assembled format. Either way, he has complete flexibility in developing his programs. Using PACE LCDS, he may view, print, and modify memory and register contents.

Once programs are debugged (LCDS contains a powerful debug monitor), the designer outputs the program or punched tape in a format compatible with National's PROM programmers.

The heart of PACE LCDS is the PACE CPU chip (#IPC-16A/520D), supported by the System Timing Element (#DP 8302N) and Bidirectional Transceiver Elements (#DP 8300N). LCDS also includes 1K x 16 bits of random access memory. Plus 1K x 16 bits of read only memory. Three on-board connectors accept standard cards to further extend the RAM, ROM and I/O capabilities. PACE LCDS features 60K x 16 bit addressability, with optional split base page operation.

The PACE LCDS comes fully assembled and tested on a heavy duty printed circuit board mounted on a 10" x 12" x 3" aluminum chassis. Order number for the PACE LCDS is IPC-16P/301. Price is $585.



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INS8080A 8-Bit N-Channel Microprocessor

general description

The INS8080A is an 8-bit microprocessor housed in a standard, 40-pin dual-in-line package. The chip, which is fabricated using N-channel silicon gate MOS technology, functions as the central processing unit (CPU) in National Semiconductor's N8080 microcomputer family.

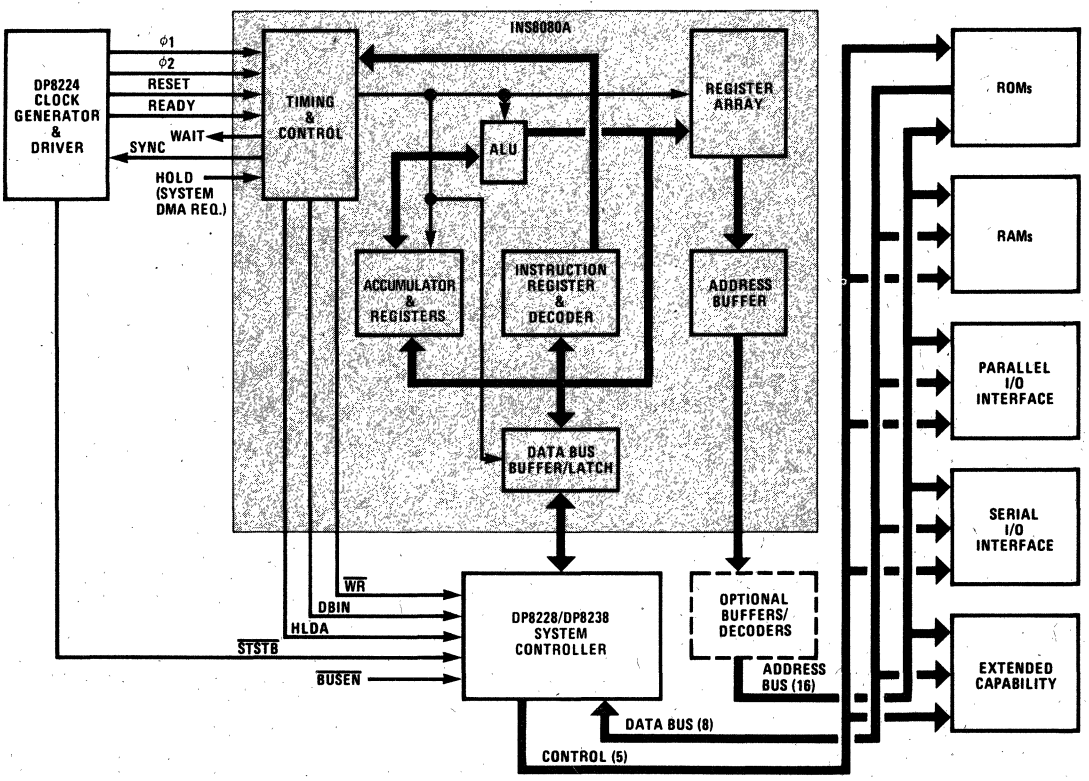
The INS8080A has a 16-bit address bus that is capable of addressing up to 65k bytes of memory and up to 256 input and 256 output devices. Data is routed to and from the INS8080A on a separate bidirectional 8-bit bus. This data bus is also TRI-STATE®, making direct memory addressing (DMA) and multiprocessing applications possible. The INS8080A directly provides signals to control the interface to memory and I/O ports. All buses, including control, are TTL compatible.

An asynchronous interrupt capability is included in the INS8080A to allow external signals to change the instruction sequence. The interrupting device may vector the program to a particular service routine location (or some other direct function) by specifying an interrupt instruction to be executed.

features

- 2μs Instruction Cycle
- Variable Length Instructions
- General Purpose Registers – Six plus an Accumulator
- Direct Addressing up to 65k Bytes
- Variable Length Stack Accessed by 16-bit Stack Pointer
- Addresses 256 Input and 256 Output Ports
- Provisions for Vectored Interrupts
- TRI-STATE® Bus for DMA and Multiprocessing Capability
- TRI-STATE TTL Drive Capabilities for Address and Data Buses
- Decimal Arithmetic Capability
- Multiple Addressing Modes
  - Direct
  - Register
  - Register Indirect
  - Immediate
- Direct Plug-in Replacement for Intel 8080A

N8080A microcomputer family block diagram



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absolute maximum ratings

Temperature Under Bias . . . . . 0°C to +70°C
Storage Temperature . . . . . -65°C to +150°C
All Input or Output Voltages
with Respect to V_{BB} . . . . . -0.3V to +20V
V_{CC}, V_{DD} and V_{SS} with Respect to V_{BB} . . -0.3V to +20V
Power Dissipation 1.5W

Note: Maximum ratings indicate limits beyond which permanent damage may occur. Continuous operation at these limits is not intended and should be limited to those conditions specified under dc electrical characteristics.

dc electrical characteristics

T_A = 0°C to +70°C, V_{DD} = +12V ± 5%, V_{CC} = +5V ± 5%, V_{BB} = -5V ± 5%, V_{SS} = 0V, unless otherwise noted.

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Condition
V_{ILC}	Clock Input Low Voltage	V_{SS}-1		V_{SS}+0.8	V	
V_{IHC}	Clock Input High Voltage	9.0		V_{DD}+1	V	
V_{IL}	Input Low Voltage	V_{SS}-1		V_{SS}+0.8	V	
V_{IH}	Input High Voltage	3.3		V_{CC}+1	V	
V_{OL}	Output Low Voltage			0.45	V	I_{OL} = 1.9mA on all outputs,
V_{OH}	Output High Voltage	3.7			V	I_{OH} = 150μA.
$I_{DD\,(AV)}$	Avg. Power Supply Current (V_{DD})		40	70	mA	Operation
$I_{CC\,(AV)}$	Avg. Power Supply Current (V_{CC})		60	80	mA	t_{CY} = 0.48μs
$I_{BB\,(AV)}$	Avg. Power Supply Current (V_{BB})		0.01	1	mA	
I_{IL}	Input Leakage			±10	μA	$V_{SS} \leqslant V_{IN} \leqslant V_{CC}$
I_{CL}	Clock Leakage			±10	μA	$V_{SS} \leqslant V_{CLOCK} \leqslant V_{DD}$
I_{DL}[2]	Data Bus Leakage in Input Mode			-100 -2.0	μA mA	$V_{SS} \leqslant V_{IN} \leqslant V_{SS}$ + 0.8V V_{SS} + 0.8V $\leqslant V_{IN} \leqslant V_{CC}$
I_{FL}	Address and Data Bus Leakage During HOLD			+10 -100	μA μA	$V_{ADDR/DATA} = V_{CC}$ $V_{ADDR/DATA} = V_{SS}$ + 0.45V

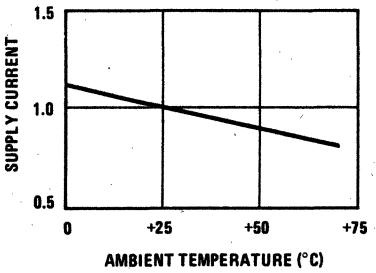
capacitance

T_A = 25°C, V_{CC} = V_{DD} = V_{SS} = 0V, V_{BB} = -5V

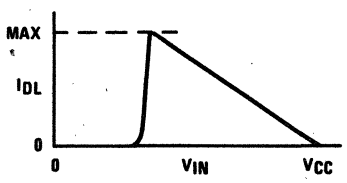
Symbol	Parameter	Typ.	Max.	Unit	Test Condition
C_ϕ	Clock Capacitance	17	25	pF	f_c = 1MHz
C_{IN}	Input Capacitance	6	10	pF	Unmeasured Pins
C_{OUT}	Output Capacitance	10	20	pF	Returned to V_{SS}

Notes:
1. The RESET signal must be active for a minimum of 3 clock cycles.
2. When DBIN is high and $V_{IN} > V_{IH}$ an internal active pullup will be switched onto the Data Bus.
3. ΔI supply / ΔT_A = -0.45%/°C.

TYPICAL SUPPLY CURRENT VS. TEMPERATURE, NORMALIZED[3]



DATA BUS CHARACTERISTIC DURING DBIN



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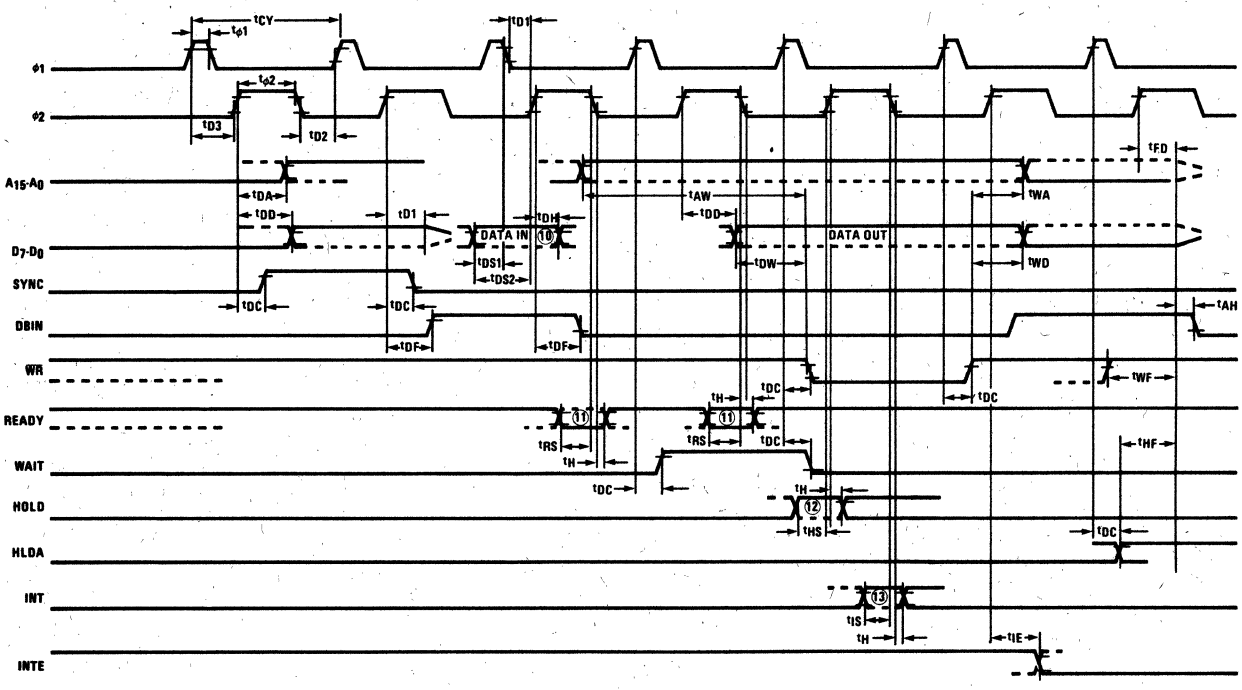
ac electrical characteristics

Symbol	Parameter	Min.	Max.	Unit	Test Condition
t_{CY} [3]	Clock Period	0.48	2.0	μs	
t_r, t_f	Clock Rise and Fall Time	0	50	ns	
$t_{\phi 1}$	ϕ_1 Pulse Width	60		ns	
$t_{\phi 2}$	ϕ_2 Pulse Width	220		ns	
t_{D1}	Delay ϕ_1 to ϕ_2	0		ns	
t_{D2}	Delay ϕ_2 to ϕ_1	70		ns	
t_{D3}	Delay ϕ_1 to ϕ_2 Leading Edges	80		ns	
t_{DA} [2]	Address Output Delay from ϕ_2		200	ns	C_L = 100pF
t_{DD} [2]	Data Output Delay from ϕ_2		220	ns	
t_{DC} [2]	Signal Output Delay from ϕ_1 or ϕ_2 (SYNC, $\overline{WR}$, WAIT, HLDA)		120	ns	C_L = 50pF
t_{DF} [2]	DBIN Delay from ϕ_2	25	140	ns	
t_{DI} [1]	Delay for Input Bus to Enter Input Mode		t_{DF}	ns	
t_{DS1}	Data Setup Time During ϕ_1 and DBIN	30		ns	

timing waveforms [14]

Note: Timing measurements are made at the following reference voltages: CLOCK '1' = 8.0V, '0' = 1.0V; INPUTS '1' = 3.3V, '0' = 0.8V; OUTPUTS '1' = 2.0V, '0' = 0.8V.



See notes on following page.

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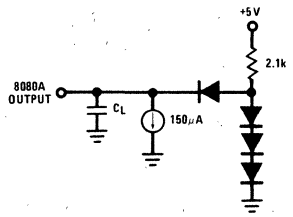
ac electrical characteristics (cont'd.)

Symbol	Parameter	Min.	Max.	Unit	Test Condition
t_{DS2}	Data Setup Time to ϕ_2 During DBIN	150		ns	
t_{DH} [1]	Data Hold Time from ϕ_2 During DBIN	1		ns	
t_{IE} [2]	INTE Output Delay from ϕ_2		200	ns	C_L = 50pF
t_{RS}	READY Setup Time During ϕ_2	120		ns	
t_{HS}	HOLD Setup Time to ϕ_2	140		ns	
t_{IS}	INT Setup Time During ϕ_2 (During ϕ_1 in Halt Mode)	120		ns	
t_H	Hold Time from ϕ_2 (READY, INT, HOLD)	0		ns	
t_{FD}	Delay to Float During Hold (Address and Data Bus)		120	ns	
t_{AW} [2]	Address Stable Prior to $\overline{WR}$	5		ns	C_L = 100pF : Address, Data C_L = 50pF: $\overline{WR}$, HLDA, DBIN
t_{DW} [2]	Output Data Stable Prior to $\overline{WR}$	6		ns	
t_{WD} [2]	Output Data Stable from $\overline{WR}$	7		ns	
t_{WA} [2]	Address Stable from $\overline{WR}$	7		ns	
t_{HF} [2]	HLDA to Float Delay	8		ns	
t_{WF} [2]	$\overline{WR}$ to Float Delay	9		ns	
t_{AH} [2]	Address Hold Time After DBIN During HLDA	-20		ns	

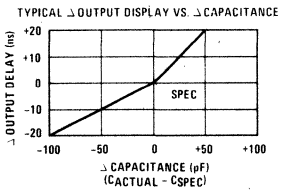
Notes:

1. Data input should be enabled with DBIN status. No bus conflict can then occur and data hold time is assured. t_{DH} = 50ns or t_{DF}, whichever is less.

2. Typical load circuit:



3. $t_{CY} = t_{D3} + t_{r\phi2} + t_{\phi2} + t_{D2} + t_{f\phi2} + t_{r\phi1} \geq 480$ns.



4. The following are relevant when interfacing the INS8080A to devices having V_{IH} = 3.3V:
   a) Maximum output rise time from 0.8V to 3.3V = 100ns @ C_L = SPEC.
   b) Output Delay when measured to 3.0V = SPEC + 60ns @ C_L = SPEC.
   c) If $C_L \neq$ SPEC, add 0.6ns/pF if $C_L > C_{SPEC}$, subtract 0.3ns/pF (from modified delay) if $C_L < C_{SPEC}$.
5. $t_{AW} = 2t_{CY} - t_{D3} - t_{r\phi2} - 140$ns.
6. $t_{DW} = t_{CY} - t_{D3} - t_{r\phi2} - 170$ns.
7. If not HLDA, $t_{WD} = t_{WA} = t_{D3} + t_{r\phi2} + 10$ns. If HLDA, $t_{WD} = t_{WA} = t_{WF}$.
8. $t_{HF} = t_{D3} + t_{r\phi2} - 50$ns.
9. $t_{WF} = t_{D3} + t_{r\phi2} - 10$ns.
10. Data in must be stable for this period during DBIN · T_3. Both t_{DS1} and t_{DS2} must be satisfied.
11. Ready signal must be stable for this period during T_2 or T_W. (Must be externally synchronized.)
12. Hold signal must be stable for this period during T_2 or T_W when entering hold mode, and during T_3, T_4, T_5, and T_{WH} when in hold mode. (External synchronization is not required.)
13. Interrupt signal must be stable during this period of the last clock cycle of any instruction in order to be recognized on the following instruction. (External synchronization is not required.)
14. This timing diagram shows timing relationships only; it does not represent any specific machine cycle.

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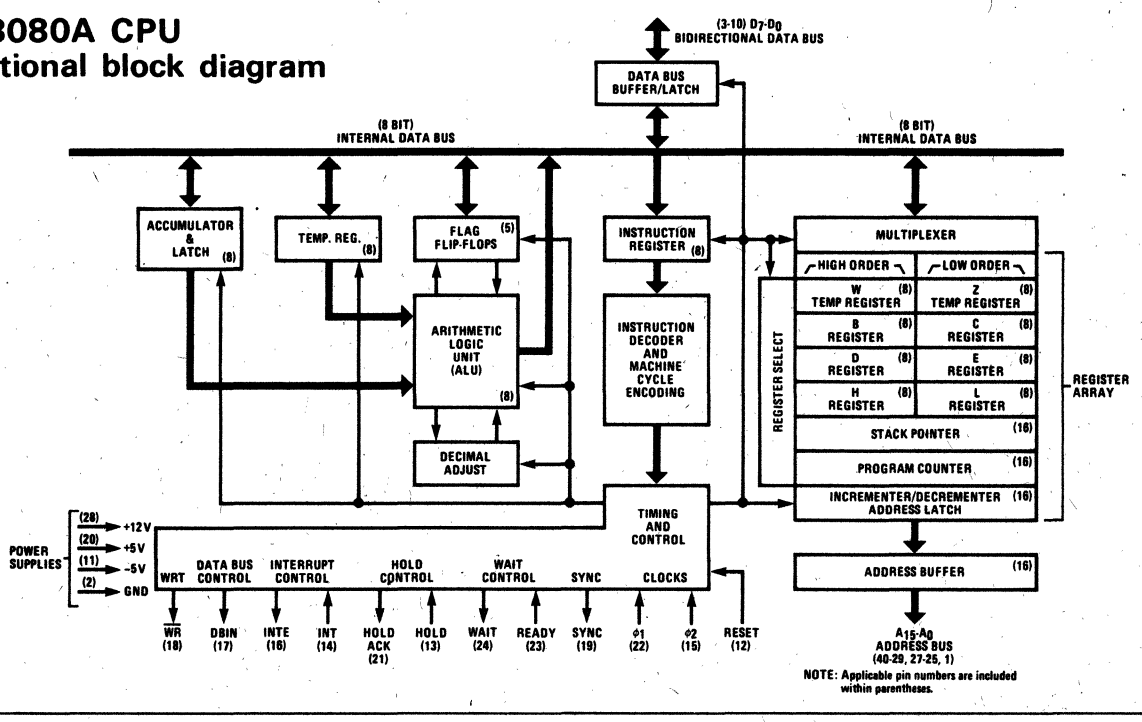
INS8080A CPU functional block diagram



INS8080A functional pin definition

The following describes the function of all of the INS8080A input/output pins. Some of these descriptions reference internal timing periods.

INPUT SIGNALS

Ready: When high (logic 1), indicates that valid memory or input data are available to the CPU on the INS8080A data bus. The READY signal is used to synchronize the CPU with slower memory or input/output devices. If the INS8080A does not receive a high READY input after sending out an address to memory or an input/output device, the INS8080A enters a WAIT mode for as long as the READY input remains low (logic 0). The CPU may also be single stepped by the use of the READY signal.

Hold: When high, requests that the CPU enter the HOLD mode. When the CPU is in the HOLD mode, the CPU address and data buses both will be in the high-impedance state. The HOLD mode allows an external device to gain control of the INS8080A address and data buses immediately following the completion of the current machine cycle by the CPU. The CPU acknowledges the HOLD mode via the HOLD ACKNOWLEDGE (HLDA) output line. The HOLD request is recognized under the following conditions:

- The CPU is in the HALT mode.
- The READY signal is active and the CPU is in the t_2 or t_W microcycle.

Interrupt (INT) Request: When high, the CPU recognizes an interrupt request on this line after completing the current instruction or while in the HALT mode. An interrupt request is not honored if the CPU is in the HOLD mode (HLDA = logic 1) or the Interrupt Enable Flip-flop is reset (INTE = logic 0).

Reset: When activated (high) for a minimum of three clock periods, the content of the Program Counter is cleared and the Interrupt Enable and Hold Acknowledge Flip-flops are reset. Following a RESET, program execution starts at memory location 0. It should be noted that the status flags, accumulator, stack pointer, and registers are not cleared during the RESET sequence.

ϕ_1 and ϕ_2 Clocks: Two non-TTL compatible clock phases which provide nonoverlapping timing references for internal storage elements and logic circuits of the CPU.

+12 Volts: V_{DD} Supply.

+5 Volts: V_{CC} Supply.

–5 Volts: V_{BB} Supply.

Ground: V_{SS} (0 volt) reference.

OUTPUT SIGNALS

Synchronizing (SYNC) Signal: When activated (high), the beginning of a new machine cycle is indicated and the status word is outputted on the Data Bus.

Address (A_{15} – A_0) Bus: This bus comprises sixteen TRI-STATE output lines. The bus provides the address to memory (up to 65k bytes) or denotes the input/output device number for up to 256 input and 256 output peripherals.

Wait: When high, acknowledges that the CPU is in the WAIT mode.

Write ($\overline{WR}$): When low, the data on the data bus are stable for WRITE memory or output operation.

Hold Acknowledge (HLDA): Goes high in response to a logic 1 on the HOLD line and indicates that the data and address bus will go to the high-impedance state. The HLDA begins at one of the following times:

- The t_3 microcycle of a READ memory input operation.
- The clock period following the t_3 microcycle of a WRITE memory output operation.

In both cases, the HLDA signal starts after the rising edge of the ϕ_1 clock, and high impedance occurs after the rising edge of the ϕ_2 clock.

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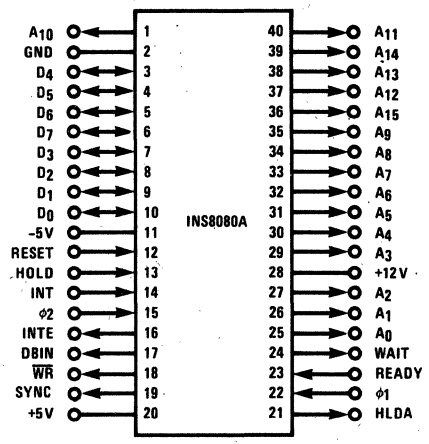
Interrupt Enable (INTE): Indicates the content of the internal Interrupt Enable Flip-flop. The Enable and Disable Interrupt (EI and DI) Instructions cause the Interrupt Enable Flip-flop to be set and reset, respectively. When the flip-flop is reset (INTE = logic 0), it inhibits interrupts from being accepted by the CPU. In addition, the Interrupt Enable Flip-flop is automatically reset (thereby disabling further interrupts) at the t_1 microcycle of the instruction fetch cycle, when an interrupt is accepted; it is also reset by the RESET Signal.

Data Bus In (DBIN): When high, indicates to external circuits that the data bus is in the input mode. The DBIN Signal should be used to gate data from memory or an I/O device onto the Data Bus.

INPUT/OUTPUT SIGNALS

Data ($D_7 - D_0$) Bus: This bus comprises eight TRI-STATE input/output lines. The bus provides bidirectional communication between the CPU, memory, and input/output devices for instructions and data transfers. A status word (which describes the current machine cycle) is also outputted on the data bus during the first microcycle of each machine cycle (SYNC = logic 1).

pin configuration



8080A status

Instructions for the 8080A require from one to five machine cycles for complete execution. The 8080A sends out 8 bits of status information on the data bus at the beginning of each machine cycle (during SYNC time). The following table defines the status information.

Status Information Definition

Symbols	Data Bus Bit	Definition
INTA*	D_0	Acknowledge signal for INTERRUPT request. Signal should be used to gate a restart instruction onto the data bus when DBIN is active.
$\overline{WO}$	D_1	Indicates that the operation in the current machine cycle will be a WRITE memory or OUTPUT function (WO = 0). Otherwise, a READ memory or INPUT operation will be executed.
STACK	D_2	Indicates that the address bus holds the pushdown stack address from the Stack Pointer.
HLTA	D_3	Acknowledge signal for HALT Instruction.
OUT	D_4	Indicates that the address bus contains the address of an output device and the data bus will contain the output data when WR is active.
M_1	D_5	Provides a signal to indicate that the CPU is in the fetch cycle for the first byte of an instuction.
INP*	D_6	Indicates that the address bus contains the address of an input device and the input data should be placed on the data bus when DBIN is active.
MEMR*	D_7	Designates that the data bus will be used for memory read data.

*These three status bits can be used to control the flow of data onto the INS8080A data bus.

Status Word Chart

Machine Cycle	Type	Data Bus Bit							
		D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
Instruction Fetch	1	1	0	1	0	0	0	1	0
Memory Read	2	1	0	0	0	0	0	1	0
Memory Write	3	0	0	0	0	0	0	0	0
Stack Read	4	1	0	0	0	0	1	1	0
Stack Write	5	0	0	0	0	0	1	0	0
Input Read	6	0	1	0	0	0	0	1	0
Output Write	7	0	0	0	1	0	0	0	0
Interrupt Acknowledge	8	0	0	1	0	0	0	1	1
Halt Acknowledge	9	1	0	0	0	1	0	1	0
Interrupt Acknowledge While Halt	10	0	0	1	0	1	0	1	1

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instruction set

Mnemonic		Description	Operation	Op Code D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	No. of Bytes	No. of Machine (M) Cycles	No. of μcycles (T)	Condition Flags S	Z	AC	P	CY
DATA TRANSFER GROUP																			
LDA		Load Accumulator Direct	(A) ← ((byte 3)(byte 2))	0	0	1	1	1	0	1	0	3	4	13					
LDAX	B	Load Accumulator Indirect	(A) ← ((B))	0	0	0	0	1	0	1	0	1	2	7					
LDAX	D	Load Accumulator Indirect	(A) ← ((D))	0	0	0	1	1	0	1	0	1	2	7					
LHLD		Load H and L Direct	(L) ← ((byte 3)(byte 2)) (H) ← ((byte 3)(byte 2) + 1)	0	0	1	0	1	0	1	0	3	5	16					
LXI	B	Load Immediate, Registers B and C	(B) ← (byte 3) (C) ← (byte 2)	0	0	0	0	0	0	0	1	3	3	10					
LXI	D	Load Immediate, Registers D and E	(D) ← (byte 3) (E) ← (byte 2)	0	0	0	1	0	0	0	1	3	3	10					
LXI	H	Load Immediate, Registers H and L	(H) ← (byte 3) (L) ← (byte 2)	0	0	1	0	0	0	0	1	3	3	10					
LXI	SP	Load Immediate, Stack Pointer	(SPH) ← (byte 3) (SPL) ← (byte 2)	0	0	1	1	0	0	0	1	3	3	10					
MOV	M, r	Move to Memory	((H)(L)) ← (r)	0	1	1	1	0	*S*	*S*	*S*	1	2	7	(Flags Not Affected)				
MOV	r, M	Move from Memory	(r) ← ((H)(L))	0	1	*D*	*D*	*D*	1	1	0	1	2	7					
MOV	r1, r2	Move Registers	(r1) ← (r2)	0	1	*D*	*D*	*D*	*S*	*S*	*S*	1	1	5					
MVI	M	Move to Memory Immediate	((H)(L)) ← (byte 2)	0	0	1	1	0	1	1	0	2	3	10					
MVI	r	Move Immediate	(r) ← (byte 2)	0	0	*D*	*D*	*D*	1	1	0	2	2	7					
SHLD		Store H and L Direct	((byte 3)(byte 2)) ← (L) ((byte 3)(byte 2) + 1) ← (H)	0	0	1	0	0	0	1	0	3	5	16					
STA		Store Accumulator Direct	((byte 3)(byte 2)) ← (A)	0	0	1	1	0	0	1	0	3	4	13					
STAX	B	Store Accumulator Indirect	((B)) ← (A)	0	0	0	0	0	0	1	0	1	2	7					
STAX	D	Store Accumulator Indirect	((D)) ← (A)	0	0	0	1	0	0	1	0	1	2	7					
XCHG		Exchange H and L with D and E	(H) ↔ (D) (L) ↔ (E)	1	1	1	0	1	0	1	1	1	1	4					
ARITHMETIC GROUP																			
ACI		Add Immediate with Carry	(A) ← (A) + (byte 2) + (CY)	1	1	0	0	1	1	1	0	2	2	7	‡	‡	‡	‡	‡
ADC	M	Add Memory with Carry	(A) ← (A) + ((H)(L)) + (CY)	1	0	0	0	1	1	1	0	1	2	7	‡	‡	‡	‡	‡
ADC	r	Add Register with Carry	(A) ← (A) + (r) + (CY)	1	0	0	0	1	*S*	*S*	*S*	1	1	4	‡	‡	‡	‡	‡
ADD	M	Add Memory	(A) ← (A) + ((H)(L))	1	0	0	0	0	1	1	0	1	2	7	‡	‡	‡	‡	‡
ADD	r	Add Register	(A) ← (A) + (r)	1	0	0	0	0	*S*	*S*	*S*	1	1	4	‡	‡	‡	‡	‡
ADI		Add Immediate	(A) ← (A) + (byte 2)	1	1	0	0	0	1	1	0	1	2	7	‡	‡	‡	‡	‡
DAA		Decimal Adjust Accumulator	8-bit number in Accumulator is converted to two 4-bit BCD digits	0	0	1	0	0	1	1	1	1	1	4	‡	‡	‡	‡	‡
DAD	B	Add B and C to H and L	(H)(L) ← (H)(L) + (B)(C)	0	0	0	0	1	0	0	1	1	3	10	·	·	·	·	‡
DAD	D	Add D and E to H and L	(H)(L) ← (H)(L) + (D)(E)	0	0	0	1	1	0	0	1	1	3	10	·	·	·	·	‡
DAD	H	Add H and L to H and L	(H)(L) ← (H)(L) + (H)(L)	0	0	1	0	1	0	0	1	1	3	10	·	·	·	·	‡
DAD	SP	Add Stack Pointer to H and L	(H)(L) ← (H)(L) + (SP)	0	0	1	1	1	0	0	1	1	3	10	·	·	·	·	‡
DCR	M	Decrement Memory	((H)(L)) ← ((H)(L)) − 1	0	0	1	1	0	1	0	1	1	3	10	‡	‡	‡	‡	·
DCR	r	Decrement Register	(r) ← (r) − 1	0	0	*D*	*D*	*D*	1	0	1	1	1	5	‡	‡	‡	‡	·
DCX	B	Decrement Registers B and C	(B)(C) ← (B)(C) − 1	0	0	0	0	1	0	1	1	1	1	5	·	·	·	·	·
DCX	D	Decrement Registers D and E	(D)(E) ← (D)(E) − 1	0	0	0	1	1	0	1	1	1	1	5	·	·	·	·	·
DCX	H	Decrement Registers H and L	(H)(L) ← (H)(L) − 1	0	0	1	0	1	0	1	1	1	1	5	·	·	·	·	·
DCX	SP	Decrement Stack Pointer	(SP) ← (SP) − 1	0	0	1	1	1	0	1	1	1	1	5	·	·	·	·	·
INR	M	Increment Memory	((H)(L)) ← ((H)(L)) + 1	0	0	1	1	0	1	0	0	1	3	10	‡	‡	‡	‡	·
INR	r	Increment Register	(r) ← (r) + 1	0	0	*D*	*D*	*D*	1	0	0	1	1	5	‡	‡	‡	‡	·
INX	B	Increment Registers B and C	(B)(C) ← (B)(C) + 1	0	0	0	0	0	0	1	1	1	1	5	·	·	·	·	·
INX	D	Increment Registers D and E	(D)(E) ← (D)(E) + 1	0	0	0	1	0	0	1	1	1	1	5	·	·	·	·	·
INX	H	Increment Registers H and L	(H)(L) ← (H)(L) + 1	0	0	1	0	0	0	1	1	1	1	5	·	·	·	·	·
INX	SP	Increment Stack Pointer	(SP) ← (SP) + 1	0	0	1	1	0	0	1	1	1	1	5	·	·	·	·	·
SBB	M	Subtract Memory with Borrow	(A) ← (A) − ((H)(L)) − (CY)	1	0	0	1	1	1	1	0	1	2	7	‡	‡	‡	‡	‡
SBB	r	Subtract Register with Borrow	(A) ← (A) − (r) − (CY)	1	0	0	1	1	*S*	*S*	*S*	1	1	4	‡	‡	‡	‡	‡
SBI		Subtract Immediate with Borrow	(A) ← (A) − (byte 2) − (CY)	1	1	0	1	1	1	1	0	2	2	7	‡	‡	‡	‡	‡
SUB	M	Subtract Memory	(A) ← (A) − ((H)(L))	1	0	0	1	0	1	1	0	1	2	7	‡	‡	‡	‡	‡
SUB	r	Subtract Register	(A) ← (A) − (r)	1	0	0	1	0	*S*	*S*	*S*	1	1	4	‡	‡	‡	‡	‡
SUI		Subtract Immediate	(A) ← (A) − (byte 2)	1	1	0	1	0	1	1	0	2	2	7	‡	‡	‡	‡	‡
LOGICAL GROUP																			
ANA	M	AND Memory	(A) ← (A) ∧ ((H)(L))	1	0	1	0	0	1	1	0	1	2	7	‡	‡	·	‡	0
ANA	r	AND Register	(A) ← (A) ∧ (r)	1	0	1	0	0	*S*	*S*	*S*	1	1	4	‡	‡	·	‡	0
ANI		AND Immediate	(A) ← (A) ∧ (byte 2)	1	1	1	0	0	1	1	0	2	2	7	‡	‡	·	‡	0
CMA		Complement Accumulator	(A) ← $(\overline{A})$	0	0	1	0	1	1	1	1	1	1	4	·	·	·	·	·
CMC		Complement Carry	(CY) ← $(\overline{CY})$	0	0	1	1	1	1	1	1	1	1	4	·	·	·	·	‡
CMP	M	Compare Memory	(A) — ((H)(L))	1	0	1	1	1	1	1	0	1	2	7	‡	‡[a]	‡	‡	‡[a]
CMP	r	Compare Register	(A) — (r)	1	0	1	1	1	*S*	*S*	*S*	1	1	4	‡	‡[b]	‡	‡	‡[b]
CPI		Compare Immediate	(A) — (byte 2)	1	1	1	1	1	1	1	0	2	2	7	‡	‡[c]	‡	‡	‡[c]
ORA	M	OR Memory	(A) ← (A) ∨ ((H)(L))	1	0	1	1	0	1	1	0	1	2	7	‡	‡	0	‡	0
ORA	r	OR Register	(A) ← (A) ∨ (r)	1	0	1	1	0	*S*	*S*	*S*	1	1	4	‡	‡	0	‡	0
ORI		OR Immediate	(A) ← (A) ∨ (byte 2)	1	1	1	1	0	1	1	0	2	2	7	‡	‡	0	‡	0
RAL		Rotate Left through Carry	$(A_{n+1}) \leftarrow (A_n)$; (CY) ← (A_7) (A_0) ← (CY)	0	0	0	1	0	1	1	1	1	1	4	·	·	·	·	‡
RAR		Rotate Right through Carry	$(A_n) \leftarrow (A_{n+1})$; (CY) ← (A_0) (A_7) ← (CY)	0	0	0	1	1	1	1	1	1	1	4	·	·	·	·	‡
RLC		Rotate Left	$(A_{n+1}) \leftarrow (A_n)$; $(A_0) \leftarrow (A_7)$ (CY) ← (A_7)	0	0	0	0	0	1	1	1	1	1	4	·	·	·	·	‡
RRC		Rotate Right	$(A_n) \leftarrow (A_{n-1})$; $(A_7) \leftarrow (A_0)$ (CY) ← (A_0)	0	0	0	0	1	1	1	1	1	1	4	·	·	·	·	‡
STC		Set Carry	(CY) ← 1	0	0	1	1	0	1	1	1	1	1	4	·	·	·	·	1
XRA	M	Exclusive OR Memory	(A) ← (A) ∀ ((H)(L))	1	0	1	0	1	1	1	0	1	2	7	‡	‡	0	‡	0
XRA	r	Exclusive OR Register	(A) ← (A) ∀ (r)	1	0	1	0	1	*S*	*S*	*S*	1	1	4	‡	‡	0	‡	0
XRI		Exclusive OR Immediate	(A) ← (A) ∀ (byte 2)	1	1	1	0	1	1	1	0	2	2	7	‡	‡	0	‡	0

Notes: a. Z = 1 if (A) = (H)(L); CY = 1 if (A) < (H)(L)
b. Z = 1 if (A) = (r); CY = 1 if (A) < (r)
c. Z = 1 if (A) = (byte 2); CY = 1 if (A) < (byte 2)

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MICROPROCESSOR National Semiconductor

instruction set (cont'd.)

Mnemonic	Description	Operation	Op Code D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	No. of Bytes	No. of Machine (M) Cycles	No. of μcycles (T)	Condition Flags S	Z	AC	P	CY
BRANCH GROUP																		
CALL	Call Unconditional	((SP) – 1) ← (PCH) ((SP) – 2) ← (PCL) (SP) ← (SP) – 2 (PC) ← (byte 3)(byte 2)	1	1	0	0	1	1	0	1	3	5	17					
CC	Call on Carry	If CY = 1, ((SP) – 1) ← (PCH) ((SP) – 2) ← (PCL) (SP) ← (SP) – 2 (PC) ← (byte 3)(byte 2)	1	1	0	1	1	1	0	0	3	3/5	11/17					
CM	Call on Minus	If S = 1, ((SP) – 1) ← (PCH) ((SP) – 2) ← (PCL) (SP) ← (SP) – 2 (PC) ← (byte 3)(byte 2)	1	1	1	1	1	1	0	0	3	3/5	11/17					
CNC	Call on No Carry	If CY = 0, ((SP) – 1) ← (PCH) ((SP) – 2) ← (PCL) (SP) ← (SP) – 2 (PC) ← (byte 3)(byte 2)	1	1	0	1	0	1	0	0	3	3/5	11/17					
CNZ	Call on Not Zero	If Z = 0, ((SP) – 1) ← (PCH) ((SP) – 2) ← (PCL) (SP) ← (SP) – 2 (PC) ← (byte 3)(byte 2)	1	1	0	0	0	1	0	0	3	3/5	11/17	(Flags Not Affected)				
CP	Call on Positive	If S = 0, ((SP) – 1) ← (PCH) ((SP) – 2) ← (PCL) (SP) ← (SP) – 2 (PC) ← (byte 3)(byte 2)	1	1	1	1	0	1	0	0	3	3/5	11/17					
CPE	Call on Parity Even	If P = 1, ((SP) – 1) ← (PCH) ((SP) – 2) ← (PCL) (SP) ← (SP) – 2 (PC) ← (byte 3)(byte 2)	1	1	1	0	1	1	0	0	3	3/5	11/17					
CPO	Call on Parity Odd	If P = 0, ((SP) – 1) ← (PCH) ((SP) – 2) ← (PCL) (SP) ← (SP) – 2 (PC) ← (byte 3)(byte 2)	1	1	1	0	0	1	0	0	3	3/5	11/17					
CZ	Call on Zero	If Z = 1, ((SP) – 1) ← (PCH) ((SP) – 2) ← (PCL) (SP) ← (SP) – 2 (PC) ← (byte 3)(byte 2)	1	1	0	0	1	1	0	0	3	3/5	11/17					
JC	Jump on Carry	If CY = 1, (PC) ← (byte 3)(byte 2)	1	1	0	1	1	0	1	0	3	3	10					
JM	Jump on Minus	If S = 1, (PC) ← (byte 3)(byte 2)	1	1	1	1	1	0	1	0	3	3	10					
JMP	Jump Unconditional	(PC) ← (byte 3)(byte 2)	1	1	0	0	0	0	1	1	3	3	10					
JNC	Jump on No Carry	If CY = 0, (PC) ← (byte 3)(byte 2)	1	1	0	1	0	0	1	0	3	3	10					
JNZ	Jump on Not Zero	If Z = 0, (PC) ← (byte 3)(byte 2)	1	1	0	0	0	0	1	0	3	3	10					
JP	Jump on Positive	If S = 0, (PC) ← (byte 3)(byte 2)	1	1	1	1	0	0	1	0	3	3	10					
JPE	Jump on Parity Even	If P = 1, (PC) ← (byte 3)(byte 2)	1	1	1	0	1	0	1	0	3	3	10					
JPO	Jump on Parity Odd	If P = 0, (PC) ← (byte 3)(byte 2)	1	1	1	0	0	0	1	0	3	3	10					
JZ	Jump on Zero	If Z = 1, (PC) ← (byte 3)(byte 2)	1	1	0	0	1	0	1	0	3	3	10					
PCHL	H and L to Program Counter	(PCH) ← (H) (PCL) ← (L)	1	1	1	0	1	0	0	1	1	1	5					
RC	Return on Carry	If CY = 1, (PCL) ← ((SP)) (PCH) ← ((SP) + 1) (SP) ← (SP) + 2	1	1	0	1	1	0	0	0	1	1/3	5/11					
RET	Return	(PCL) ← ((SP)); (PCH) ← ((SP) + 1); (SP) ← (SP) + 2;	1	1	0	0	1	0	0	1	1	3	10					
RM	Return on Minus	If S = 1, (PCL) ← ((SP)) (PCH) ← ((SP) + 1) (SP) ← (SP) + 2	1	1	1	1	1	0	0	0	1	1/3	5/11					
RNC	Return on No Carry	If CY = 0, (PCL) ← ((SP)) (PCH) ← ((SP) + 1) (SP) ← (SP) + 2	1	1	0	1	0	0	0	0	1	1/3	5/11					
RNZ	Return on Not Zero	If Z = 0, (PCL) ← ((SP)) (PCH) ← ((SP) + 1) (SP) ← (SP) + 2	1	1	0	0	0	0	0	0	1	1/3	5/11					
RP	Return on Positive	If S = 0, (PCL) ← ((SP)) (PCH) ← ((SP) + 1) (SP) ← (SP) + 2	1	1	1	1	0	0	0	0	1	1/3	5/11					
RPE	Return on Parity Even	If P = 1, (PCL) ← ((SP)) (PCH) ← ((SP) + 1) (SP) ← (SP) + 2	1	1	1	0	1	0	0	0	1	1/3	5/11					
RPO	Return on Parity Odd	If P = 0, (PCL) ← ((SP)) (PCH) ← ((SP) + 1) (SP) ← (SP) + 2	1	1	1	0	0	0	0	0	1	1/3	5/11					

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instruction set (cont'd.)

Mnemonic	Description	Operation	Op Code D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	No. of Bytes	No. of Machine (M) Cycles	No. of μcycles (T)	Condition Flags S	Z	AC	P	CY
BRANCH GROUP (continued)																		
RST	Restart	((SP) – 1) ← (PCH) ((SP) – 2) ← (PCL) (SP) ← (SP) – 2 (PC) ← 8 * (NNN)	1	1	*N*	*N*	*N*	1	1	1	1	3	11					
RZ	Return on Zero	If Z = 1, (PCL) ← ((SP)) (PCH) ← ((SP) + 1) (SP) ← (SP) + 2	1	1	0	0	1	0	0	0	1	1/3	5/11					
STACK, I/O, AND MACHINE CONTROL GROUP																		
DI	Disable Interrupts	The Interrupt system is disabled following the execution of the DI instruction.	1	1	1	1	0	0	1	1	1	1	4	·	·	·	·	·
EI	Enable Interrupts	The interrupt system is enabled following the execution of next instruction.	1	1	1	1	1	0	1	1	1	1	4	·	·	·	·	·
HLT	Halt	Processor is stopped; registers and flags are unaffected.	0	1	1	1	0	1	1	0	1	1	7	·	·	·	·	·
IN	Input	(A) ← (data)	1	1	0	1	1	0	1	1	2	3	10	·	·	·	·	·
NOP	No Operation	No operation is performed; registers and flags are unaffected.	0	0	0	0	0	0	0	0	1	1	4	·	·	·	·	·
OUT	Output	(data) ← (A)	1	1	0	1	0	0	1	1	2	3	10	·	·	·	·	·
POP B	Pop Registers B and C off Stack	(C) ← ((SP)) (B) ← ((SP) + 1) (SP) ← (SP) + 2	1	1	0	0	0	0	0	1	1	3	10	·	·	·	·	·
POP D	Pop Registers D and E off Stack	(D) ← ((SP)) (E) ← ((SP) + 1) (SP) ← (SP) + 2	1	1	0	1	0	0	0	1	1	3	10	·	·	·	·	·
POP H	Pop Registers H and L off Stack	(H) ← ((SP)) (L) ← ((SP) + 1) (SP) ← (SP) + 2	1	1	1	0	0	0	0	1	1	3	10	·	·	·	·	·
POP PSW	Pop Accumulator and Flags off Stack	(CY) ← $((SP))_0$ (P) ← $((SP))_2$ (AC) ← $((SP))_4$ (Z) ← $((SP))_6$ (S) ← $((SP))_7$ (A) ← ((SP) + 1) (SP) ← (SP) + 2	1	1	1	1	0	0	0	1	1	3	10	‡	‡	‡	‡	‡
PUSH B	Push Registers B and C on Stack	((SP) – 1) ← (B) ((SP) – 2) ← (C) (SP) ← (SP) – 2	1	1	0	0	0	1	0	1	1	3	11	·	·	·	·	·
PUSH D	Push Registers D and E on Stack	((SP) – 1) ← (D) ((SP) – 2) ← (E) (SP) ← (SP) – 2	1	1	0	1	0	1	0	1	1	3	11	·	·	·	·	·
PUSH H	Push Registers H and L on Stack	((SP) – 1) ← (H) ((SP) – 2) ← (L) (SP) ← (SP) – 2	1	1	1	0	0	1	0	1	1	3	11	·	·	·	·	·
PUSH PSW	Push Accumulator and Flags on Stack	((SP) – 1) ← (A) $((SP) – 2)_0$ ← (CY) $((SP) – 2)_1$ ← 1 $((SP) – 2)_2$ ← (P) $((SP) – 2)_3$ ← 0 $((SP) – 2)_4$ ← (AC) $((SP) – 2)_5$ ← 0 $((SP) – 2)_6$ ← (Z) $((SP) – 2)_7$ ← (S) (SP) ← (SP) – 2	1	1	1	1	0	1	0	1	1	3	11	·	·	·	·	·
SPHL	Move H and L to Stack Pointer	(SP) ← (H) (L)	1	1	1	1	1	0	0	1	1	1	5	·	·	·	·	·
XTHL	Exchange Top of Stack with H and L	(L) ↔ ((SP)) (H) ↔ ((SP) + 1)	1	1	1	0	0	0	1	1	1	5	18	·	·	·	·	·

condition flags and standard rules

There are five condition flags associated with the execution of instructions on the INS8080A. They are Zero, Sign, Parity, Carry, and Auxiliary Carry, and each flag is represented by a 1-bit register in the CPU. A flag is "set" by forcing the bit to 1, "reset" by forcing the bit to 0. The bit positions of the flags are indicated in the PUSH and POP PSW instructions.

Unless indicated otherwise, when an instruction affects a flag, it affects it in the following manner:

ZERO (Z): If the result of an instruction has the value 0, this flag is set; otherwise, it is reset.

SIGN (S): If the most significant bit of the result of the operation has the value 1, this flag is set; otherwise, it is reset.

PARITY (P): If the modulo 2 sum of the bits of the result of the operation is 0 (that is, if the result has even parity), this flag is set; otherwise, it is reset (that is, if the result has odd parity).

CARRY (CY): If the instruction resulted in a carry (from addition) or a borrow (from subtraction or a comparison) out of the high-order bit, this flag is set; otherwise, it is reset.

AUXILIARY CARRY (AC): If the instruction caused a carry out of bit 3 and into bit 4 of the resulting value, the auxiliary carry is set; otherwise, it is reset. This flag is affected by single-precision additions, subtractions, increments, decrements, comparisons, and logical operations; however, AC is used principally with additions and increments preceding a DAA (Decimal Adjust Accumulator) Instruction.

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symbols and abbreviations

The following symbols and abbreviations are used in the subsequent description of the INS8080A instructions:

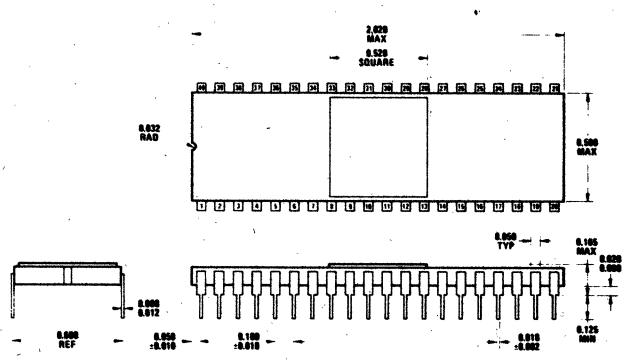
Symbols	Meaning
A	Register A (Accumulator)
B	Register B
C	Register C
D	Register D
H	Register H
L	Register L
DDD, SSS	The bit pattern designating one of the registers A, B, C, D, E, H, L (DDD = destination, SSS = source):

DDD or SSS	Register Name
111	A
000	B
001	C
010	D
011	E
100	H
101	L

byte 2	The second byte of the instruction
byte 3	The third byte of the instruction
port	8-bit address of an I/O device
r, r1, r2	One of the registers A, B, C, D, E, H, L

Symbols	Meaning
PC	16-bit program counter register (PCH and PCL are used to refer to the high-order and low-order 8 bits respectively.)
SP	16-bit stack pointer register (SPH and SPL are used to refer to the high-order and low-order 8 bits respectively.)
( )	The contents of the memory location or registers enclosed in the parentheses
←	"Is replaced by"
Λ	Logical AND
∀	Exclusive OR
V	Inclusive OR
+	Addition
–	Twos complement subtraction
*	Multiplication
↔	"Exchange"
—	The ones complement (for example, $(\overline{A})$)
n	The restart number 0 through 7
NNN	The binary representation 000 through 111 for restart number 0 through 7 respectively
•	"Not affected"
0	"Reset"
1	"Set"
x	Unknown
↕	Flags affected according to Standard Rules

physical dimensions



Ceramic Dual-In-Line Package (D)
Order Number INS8080AD

Manufactured under one or more of the following U.S. patents: 3083262, 3189758, 3231797, 3303356, 3317671, 3323071, 3381071, 3408542, 3421025, 3426423, 3440498, 3518750, 3519897, 3557431, 3560765, 3566218, 3571630, 3575609, 3579059, 3593069, 3597640, 3607469, 3617859, 3631312, 3633052, 3638131, 3648071, 3651565, 3693248.

National Semiconductor Corporation
2900 Semiconductor Drive, Santa Clara, California 95051, (408) 737-5000/TWX (910) 339-9240
National Semiconductor GmbH
808 Fuerstenfeldbruck, Industriestrasse 10, West Germany, Tele. (08141) 1371/Telex 05-27649
National Semiconductor (UK) Ltd.
Larkfield Industrial Estate, Greenock, Scotland, Tele. (0475) 33251/Telex 778-632

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IMP-16A/521D, IMP-16A/522D, IMP-8A/520D
MOS/LSI control and read only memory unit (CROM)

general description

The Control and Read Only Memory Unit (CROM) is a member of a new family of microprocessor devices, and is a monolithic MOS/LSI circuit utilizing standard P-channel, enhancement mode, silicon gate technology. It provides read only microprogram storage and control logic and is designed for use with the Register and Arithmetic Logic Unit (RALU). The CROM provides storage for one-hundred microinstructions of 23 bits each. Circuitry is also provided for program sequencing, subroutine execution, and translation of microinstructions into RALU commands. One CROM may be used with 1 to 8 RALU's to implement systems with 4 to 32-bit word lengths. Multiple CROM's may be used to provide expanded capability. CROM's are available with standard 8 and 16-bit instruction sets. (Other sets may be available in the future.)

The CROM operates on +5V and −12V supplies with 4-phase, non-overlapping clocks. Signals which are intended for interface with the RALU are MOS level, while those which are intended for interfacing with the rest of the system are TTL levels.

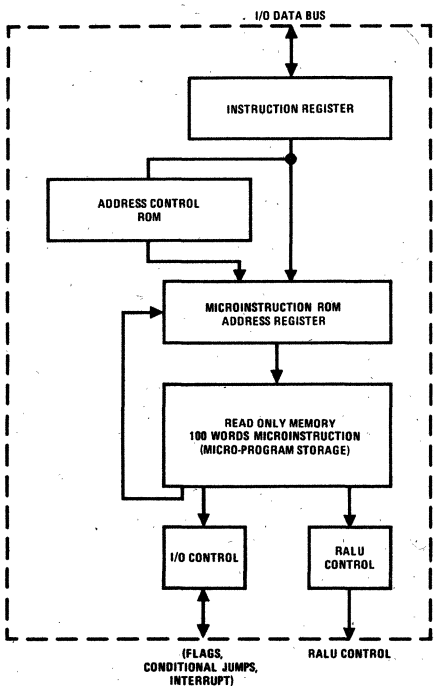
features

- Standard supplies — +5V, −12V
- Bipolar compatibility — Drives TTL
- Standard package — 24 pin DIP
- High speed — ~ 700 kHz
- Microprogrammable — 100 words
- Subroutine capability — Return address register
- Expandable — Up to 4 CROM's

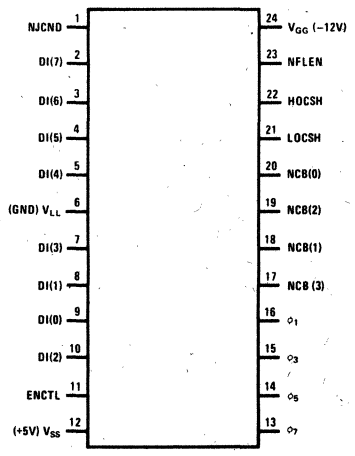
applications

- Standard IMP instruction sets
- Expansion of standard instruction sets
- Custom instruction sets
- Custom application control programs
- Control of 4 to 32-bit microprocessors when used with Register and Arithmetic Logic Unit

block and connection diagrams



Dual-In-Line Package



TOP VIEW

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absolute maximum ratings

All Input or Output Voltages With Respect to Most Positive Supply Voltage (V_{SS})	+0.3V to −20V
Operating Temperature Range	0°C to +70°C
Storage Temperature	−65°C to +150°C
Power Dissipation	1W Maximum at +25°C

Note: Maximum ratings indicate limits beyond which permanent damage may occur. Continuous operation at these limits is not intended and should be limited to those conditions specified under dc electrical characteristics.

electrical characteristics

(T_A = 0°C to +70°C; V_{SS} = +5V ±5%; V_{GG} = −12V ±5%, V_{LL} = GND)

PARAMETER	CONDITIONS	MIN (Note 2)	TYP	MAX (Note 2)	UNITS
Logic "1" Input (MOS and TTL) ($V_{IN(1)}$) (Note 1)		V_{SS} − 1			V
Logic "0" Input (MOS) ($V_{IN(0)}$)				V_{SS} − 7.0	V
Logic "0" Input (TTL) ($V_{IN(0)}$)				V_{SS} − 4.2	V
Logic "0" Input Current (TTL) ($I_{IN(0)}$)	V_{IN} = 0V			−1.75	mA
Input Leakage Current (MOS) (I_L)	V_{IN} = +5.0 to −12V			2	μA
Logic "1" Output (MOS) ($V_{OUT(1)}$)		V_{SS} − 0.6			V
Logic "0" Output (MOS) ($V_{OUT(0)}$)				V_{SS} − 8.0	V
Logic "1" Output (TTL) ($V_{OUT(1)}$)	I_{OUT} = 0.2 mA	2.4			V
Logic "0" Output (TTL) ($V_{OUT(0)}$)	I_{OUT} = −2.0 mA			0.4	V
Pull-up Transistor "on" Resistance ($R_{PULL-UP}$) (Note 1)	V_{IN} = V_{SS} − 1.0V	3.0		5.0	kΩ
DI(0) − DI(7) Input Capacitance (C_S)	V_{IN} = V_{SS}, f_T = 700 kHz		5.0	10	pF
NJCND, ENCTL, LOCSH, HOCSH Input Capacitance	V_{IN} = V_{SS}, f_T = 700 kHz		11	14	pF
Clock Input Capacitance (C_C)	V_{IN} = V_{SS}, f_T = 700 kHz	30	40	60	pF
Clock "1" Level ($V_{\phi(1)}$) (Note 3)		V_{SS} − 1.0		V_{SS}	V
Clock "0" Level ($V_{\phi(0)}$)		V_{GG}		V_{GG} + 1.0	V
Load Capacitance For D1(0), (1), (2), (3) (C_L)				25	pF
HOCSH, LOCSH				22	pF
ENCTL, NFLEN				20	pF
NCB(0), (1), (2), (3)				50	pF
Power Dissipation (P_D) (T_1 − T_8 Equal Width)	f = 700 kHz		700	950	mW

Note 1: Internal pullup provided for TTL inputs. Refer to Figure 3 and text.

Note 2: Max. = most positive; Min. = most negative.

Note 3: Clamp diodes and series damping resistors may be required to prevent clock overshoot.

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FUNCTIONAL DESCRIPTION

A block diagram of the Control and Read Only Memory (CROM) chip is shown in Figure 1. The ROM provides storage for one-hundred 23-bit microinstructions. This is sufficient to implement a macroinstruction set comparable to many mini-computers, or to provide a control program directly in microcode. In cases where larger programs are desired, up to four CROM chips may be used in a single processor. (CROM's which implement 8- and 16-bit instruction sets are available as standard products.)

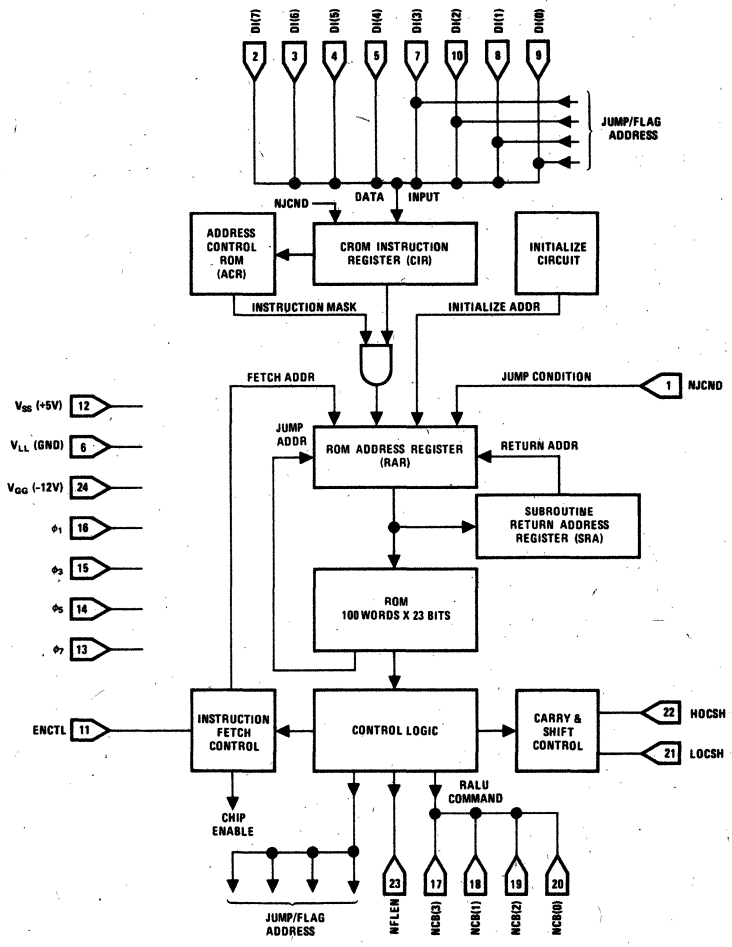
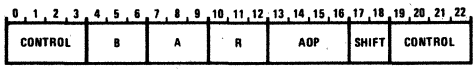


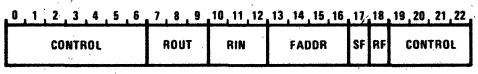
FIGURE 1. CROM Block Diagram

TABLE I. IMP Microinstruction Word Formats

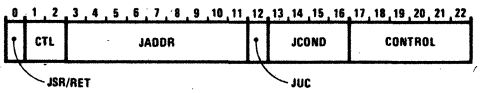
ARITHMETIC INSTRUCTIONS



I/O INSTRUCTIONS



JUMP INSTRUCTIONS



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A simplified version of the ROM bit functions is indicated in Table I. For explanation purposes the functions have been divided into three classes. The class is specified by the control fields, which are also used for special functions. The arithmetic class allows specification of the registers to be loaded on the A and B-bus of the RALU, the ALU operation to be performed (AOP), a shift operation and the register to be loaded from the R-bus. The I/O class provides fields for addressing a register for data output and a register for data input as well as setting (SF) and/or resetting (RF) one of 16 external control flags to indicate the type of I/O transfer. The microinstruction jump class provides a 9-bit address field, selection of up to 16 jump conditions (JCOND), an unconditional jump command (JUC) and specification of a subroutine jump or return (JSR/RET). (The jump condition and flag logic is provided off the chip to save pins. Standard product bipolar MSI circuits are available which provide eight control flags in a single addressable latch and 8 or 16 jump conditions with a single multiplexer.)

The ROM has 9 programmable address inputs which come from the ROM address register (RAR). The RAR is a 9-bit synchronous counter with parallel load inputs which normally counts sequentially through ROM addresses. When a program branch is desired the contents of the RAR may be altered by parallel loading from one of several sources. One possibility is to load an address specified by the microcode stored in the ROM. This may be either a conditional or unconditional branch. Conditional branches are controlled by the jump condition input (NJCND). An external jump condition multiplexer drives NJCND and may apply one of up to 16 conditions to the input. The condition applied is selected by the jump/flag address which is sent out over pins DI(0), (1), (2), and (3) at the beginning of each microinstruction cycle. The RAR may also be loaded from the subroutine address register (SRA). This register is loaded from the RAR if a jump to subroutine is specified by the microcode. The SRA is loaded back into the RAR when a return from subroutine is executed. There are two programmable addresses which may be loaded into the RAR. These are the address of the instruction fetch routine, which will be loaded into the RAR when a new macroinstruction is to be "fetched" from the system memory, and the address of the initialize routine, which will be loaded when the power is turned on. The final method of loading the RAR is from the CROM instruction register (CIR). This register is loaded from external memory, or an I/O device, with a macroinstruction to be executed. The CIR is loaded into the RAR as commanded by the microprogrammed "fetch" routine. The CIR bits are masked by the outputs of the Address Control ROM (ACR) before being loaded into the RAR. The masking is used to set bits which are not part of the instruction opcode to zero. There are 12 masks available; the one used is selected by the current contents of the CIR (i.e., each instruction selects its own mask). The selection code and masks are both programmable.

The HOCSH and LOCSH (High and Low Order Carry/Shift) signals are used to implement carry and shift operations. LOCSH is used to provide a low order carry in for the ALU. This is useful for incrementing, two's complementing a number or emitting (serial) bit patterns to the ALU. During circular shift operations HOCSH and LOCSH are tied together by an internal transistor, allowing shifts to propagate between the most and least significant ALU bits. In the case of open shifts the HOCSH and LOCSH pins provide trailing zeroes to be shifted into the ALU.

Control information from the CROM to the RALU is sent over four time-multiplexed lines (NCB(0), (1), (2), and (3)). Four 4-bit commands are sent each microinstruction cycle. These lines go to all RALU chips in parallel. The enable control pin (ENCTL) and the chip enable circuitry are used for systems having more than one CROM (for microprograms with more than 100 words).

Details of signal functions and timing are presented in the following sections. Positive true logic signals are used ("1" = more positive voltage, "0" = more negative voltage). Signal names beginning with N are complemented signals.

FUNCTIONAL DESCRIPTION OF SIGNALS

The timing diagram (Figure 2) is divided into 8 time intervals (T_1 - T_8) based on the 4-phase non-overlapping clocks. The clock inputs have MOS levels of +5V and -12V and occur during the odd time intervals. Thus phase 1 is a logic "0" (-12V) during T_1 and a logic "1" (+5V) during T_2 - T_8.

Commands

The command outputs to the RALU occur on pins 20, 18, 19, and 17 which correspond to command bits NCB(0), (1), (2), and (3). The command outputs are complemented MOS signals and are multiplexed over the 4 odd time intervals in each cycle (T_1, T_3, T_5, T_7). Outputs are driven negative to logic "0" during the even time intervals. The command functions for each bit are indicated in the diagram. During T_1, the three least significant command bits specify the address of the register to be loaded onto the A-bus. Registers R_1 - R_7 are addressed by binary values of 1 - 7 respectively. A value of zero causes the A-bus to be set equal to zero. The fourth command bit is used to enable stack operations. If NCB(3) is at a logic "1" (most positive level) no stack operation occurs. If it is at a logic "0" stack operations are enabled, but will only occur if the A or R-bus address is zero. If the A-bus address is zero the stack will be pulled onto the A-bus. If the R-bus address is zero, the R-bus will be pushed onto the stack.

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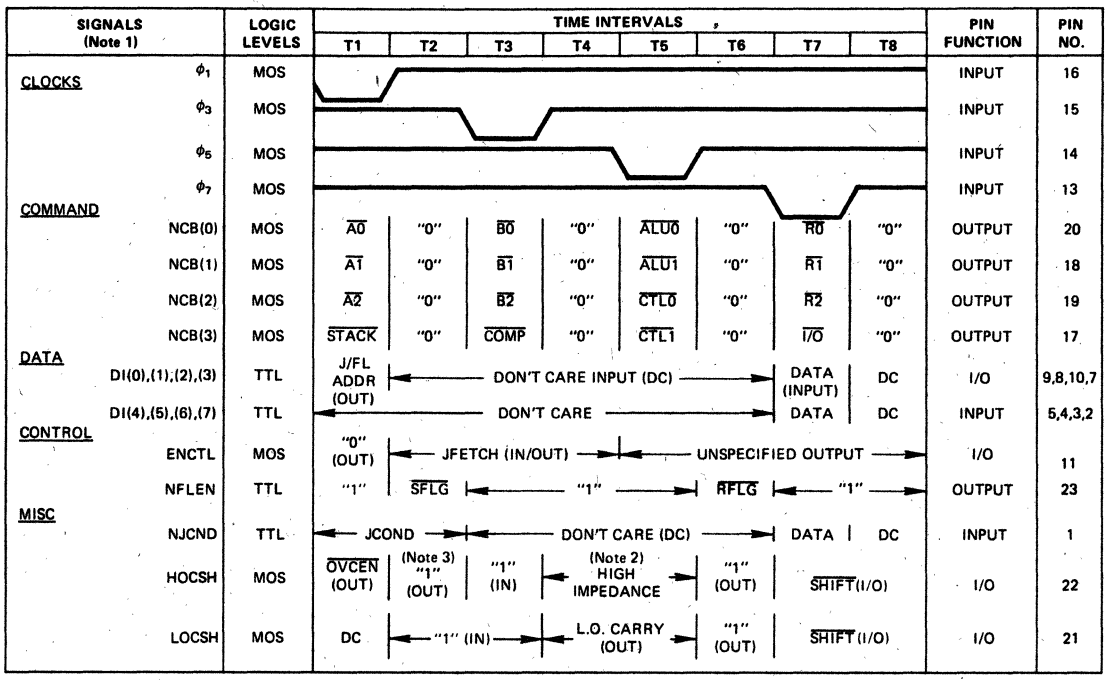

Note 1: A positive true logic convention is used for all signals except clocks. Signal names beginning with N are complemented signals.

Note 2: HOCSH at T4 and T5 is in the TRI-STATE high impedance output mode of CROM load drivers.

Note 3: "1" (OUT) means CROM is driving this node to the logic "1" level during the defined interval. For I/O lines the logic state is defined as "in" or "out." Input or output nodes are defined only as "1" or "0."

FIGURE 2. CROM Timing Diagram

During T_3 the three least significant bits specify the address of the register (R_1 - R_7) to be loaded on the B-bus. The most significant bit specifies that the A-bus is to be complemented when it is transferred to the IA-bus. During T_5 NCB(1) and NCB(0) specify the ALU operation to be performed, while NCB(3) and NCB(2) are used to specify control functions.

During T_7 the three least significant bits specify the address of the register (R_1 - R_7) to be loaded from the R-bus. The most significant bit specifies that the R-bus is to be set equal to the output of the I/O multiplexer rather than the shifter.

Data

Instructions to the CROM are transferred over the data input lines (DI(0) - DI(7)) into bits 0 - 7 of the CIR. (Bit 8 of the CIR is loaded from the NJCND input.) Data input occurs at T_7. As with all TTL inputs on the CROM a 3k - 5k pull-up is provided on the chip to insure an adequate logic "1" level (see Figure 3). The pull-up is provided by an MOS transistor which is turned on during the data input interval (T_7). Signal lines DI(0) - DI(3) are also used to output a 4-bit address to the control flags and jump conditions. This address output becomes valid during T_1 and must be stored in an external latch at the end of T_1.

Control Signals

The enable control (ENCTL) is a "wired-or" signal line required for operation of multiple CROM's. It provides a logic "1" output at T_2 - T_4 whenever a branch to the instruction fetch routine occurs, and responds to a logic "1" input at T_2 - T_4 by executing a branch to the instruction fetch routine and disabling if the instruction has not been implemented in that particular CROM. The flag enable (NFLEN) control output is used to set or reset flags addressed by DI(0) - DI(3) at T_1 of the current cycle. A logic "0" output at T_2 specifies setting of the addressed flag while a logic "0" output at T_6 specifies resetting.

Miscellaneous Signals

The jump condition input line (NJCND) is used to input conditional branch information at T_1 and T_2 as specified by the jump condition addressed by DI(0) - DI(3) at T_1. If the input is a logic "0" and a conditional branch has been specified for the current cycle, a branch will occur. The NJCND input is also used to load data into CIR(8) at T_7.

The high and low order carry/shift lines (HOCSH and LOCSH) are used to provide shift and carry information to the RALU chips. If a circular shift has been specified, HOCSH and LOCSH are connected together on the CROM during T_7 and T_8 by a low on-resistance MOS transistor switch. For

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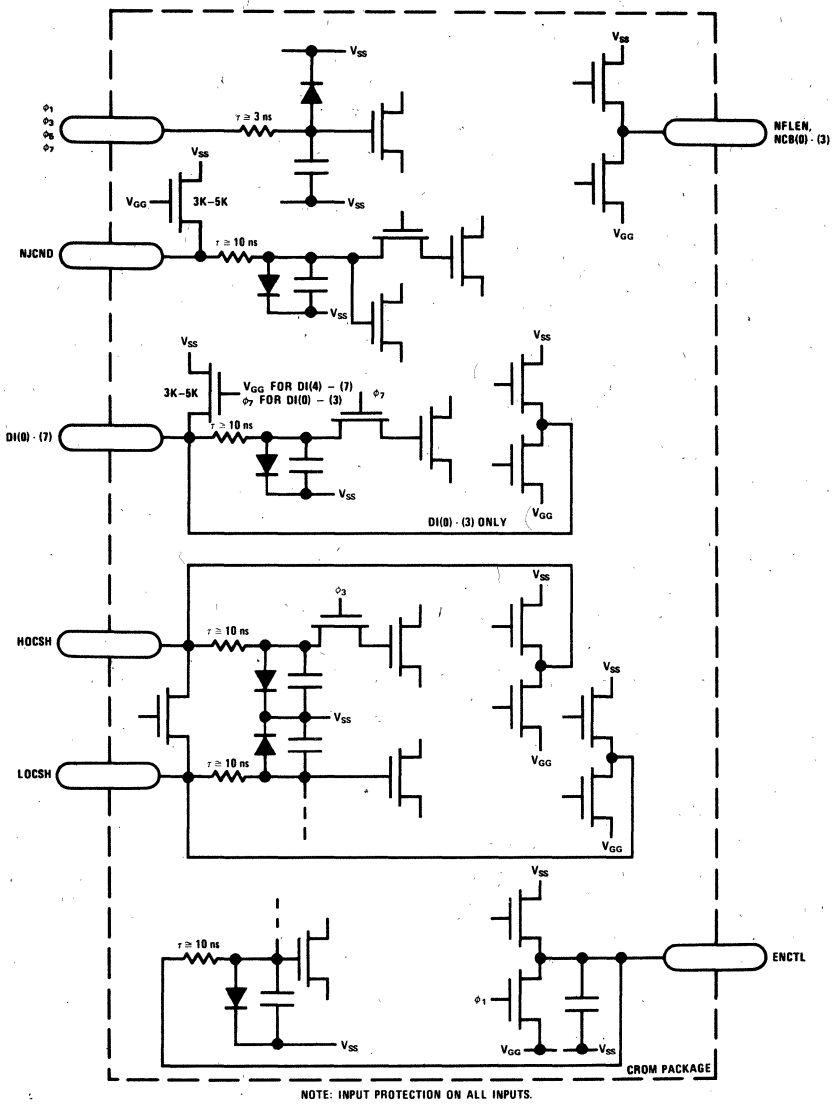

FIGURE 3. CROM Driver and Receiver Buffer

the case of a circular left shift HOCSH serves as an input driven by the most significant RALU and LOCSH serves as an output to the least significant RALU and follows the voltage input at HOCSH. The direction of data transfer is reversed for circular right shift. In the case of open ended shifts the CROM output (LOSCH for left shift and HOCSH for right shift) provides a logic "1" to the RALU (since the shift data is complemented this will provide a trailing "0" for the shift operation) and ignores the shift input data from the RALU. The carry input to the least significant RALU is provided by LOCSH at T_4 and T_5. The overflow and carry flags on the RALU are enabled by the output of HOCSH at T_1. A logic "1" input is required to HOCSH at T_3. This line is precharged to a logic "1" at T_2. A logic "1" input is required for LOCSH at T_2 and T_3. The LOCSH input will be precharged to a logic "1" at T_1 when connected to CSH0 of an RALU.

SIGNAL TIMING SPECIFICATIONS

The timing specifications for all CROM signals are shown in Figure 4. These specifications apply over the complete range of recommended operating conditions. Time intervals are defined with respect to the 10% and 90% points of the four MOS clock inputs. The command outputs on the NCB bus become valid within the first 85 ns of the odd time intervals. These lines are driven to a logic zero within the first 85 ns of the even time intervals. The jump condition and flag address outputs on DI(0) – DI(3) become valid within the first 80 ns of T_1 and remain valid for at least 10 ns after the 90% point at the end of T_1. Data inputs to all DI lines must be valid for at least the last 35 ns of T_7 and must remain valid until the 10% point at the start of T_8. Timing for the remaining signals is similar. (Note that signals may not change state during "valid" time intervals.)

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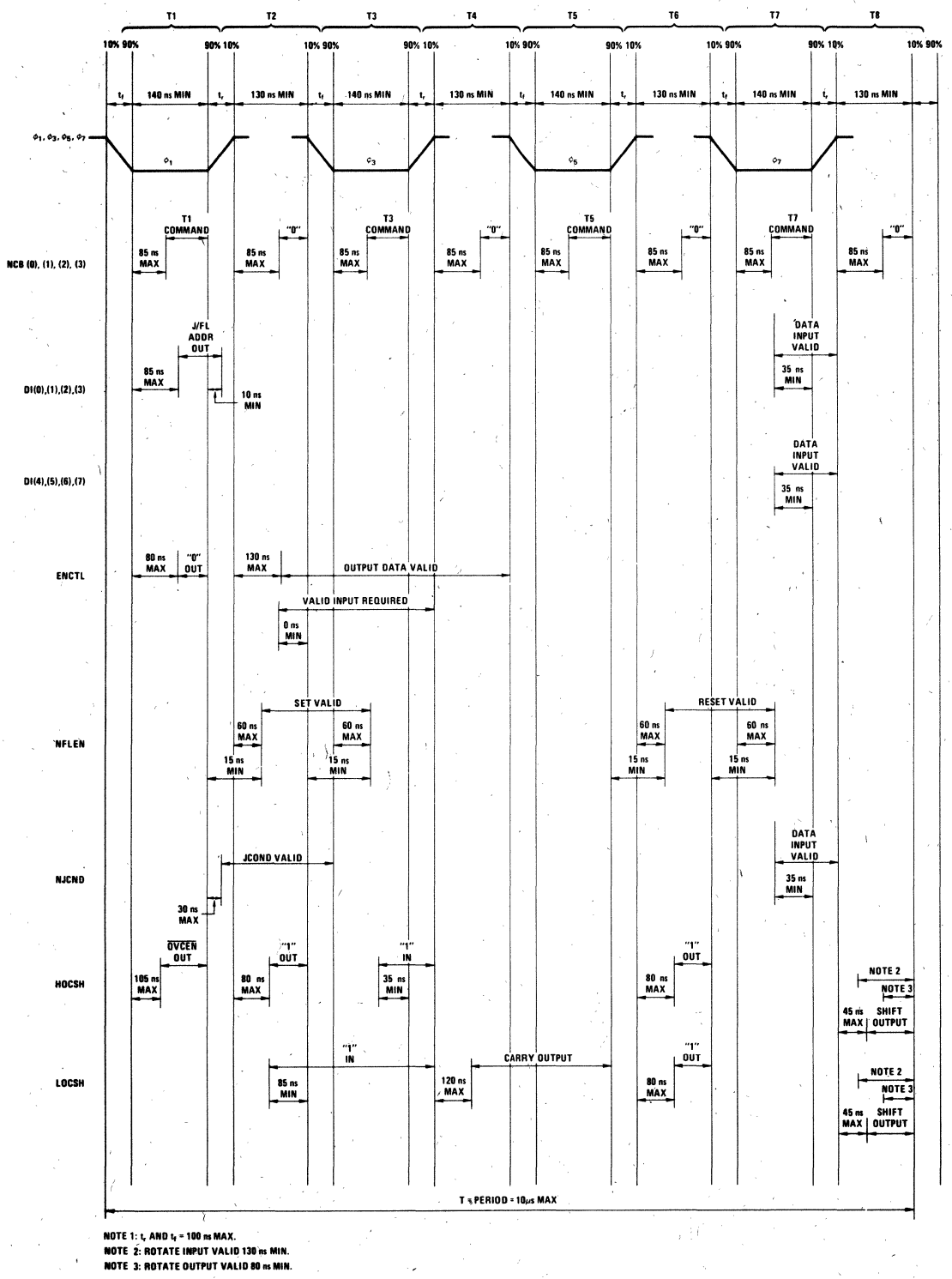

NOTE 1: t_r AND t_f = 100 ns MAX.
NOTE 2: ROTATE INPUT VALID 130 ns MIN.
NOTE 3: ROTATE OUTPUT VALID 80 ns MIN.

FIGURE 4. CROM Signal Timing Specifications

(T_A = 0°C to +70°C, V_{SS} = +5V ±5%, V_{GG} = −12V ±5%, V_{LL} = GND)

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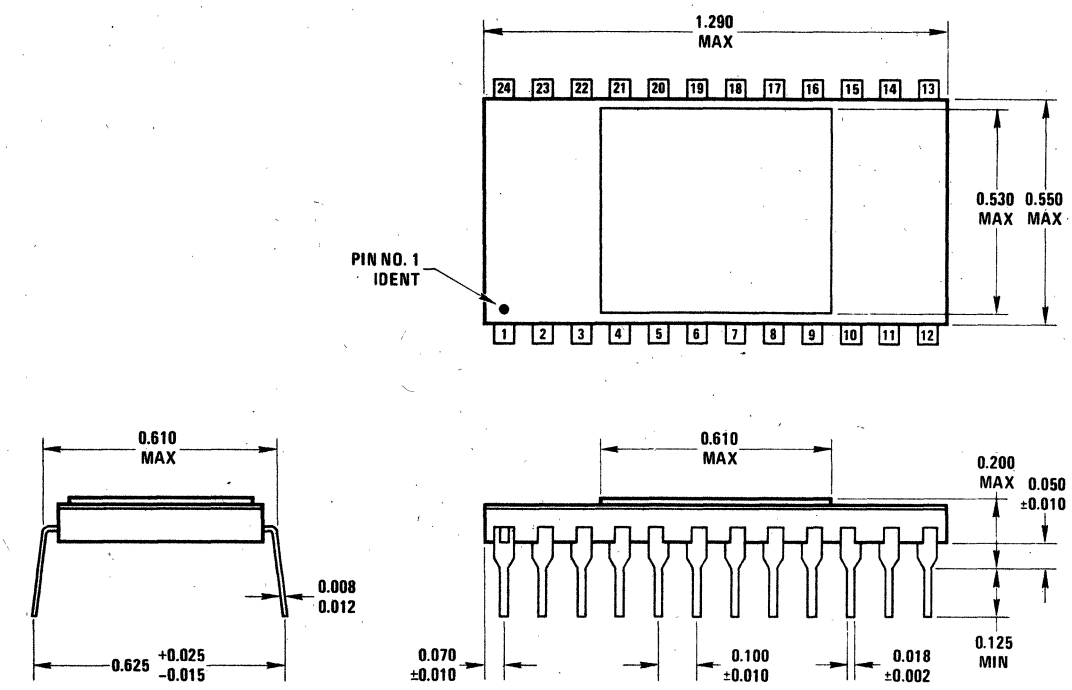
physical dimensions



Cavity Dual-In-Line Package (D)

ordering information

The basic CROM device is available with a variety of different microcode masks to tailor it to different applications. The mask versions defined so far include:

IMP-16A/521D	16-Bit Standard Instruction Set
IMP-16A/522D	16-Bit Extended Instruction Set
IMP-8A/520D	8-Bit Standard Instruction Set
IMP-4A/521D	4-Bit Standard Instruction Set

Manufactured under one or more of the following U.S. patents: 3083262, 3189758, 3231797, 3303356, 3317671, 3323071, 3381071, 3408542, 3421025, 3426423, 3440498, 3518750, 3519897, 3557431, 3560765, 3566218, 3571630, 3575609, 3579059, 3593069, 3597640, 3607469, 3617859, 3631312, 3633052, 3638131, 3648071, 3651565, 3693248.

National Semiconductor Corporation
2900 Semiconductor Drive, Santa Clara, California 95051, (408) 737-5000/TWX (910) 339-9240
National Semiconductor GmbH
808 Fuerstenfeldbruck, Industriestrasse 10, West Germany, Tele. (08141) 1371/Telex 05-27649
National Semiconductor (UK) Ltd.
Larkfield Industrial Estate, Greenock, Scotland, Tele. (0475) 33251/Telex 778-632

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IMP-00A/520 MOS/LSI register and arithmetic logic unit (RALU)

general description

The IMP-00A/520 is a member of a new family of microprocessor elements, and is a monolithic MOS/LSI circuit utilizing standard P-channel, enhancement mode, silicon gate technology. It provides a 4-bit slice of the register and arithmetic portion of a general purpose controller/processor. RALU's may be stacked in parallel for longer word lengths. The RALU is designed to be used with other members of National's IMP family (in particular the CROM) to form a complete processor. Each RALU provides 96 bits of storage in the form of 4 bits in each of 7 general registers, a status register and a 16-word last in, first out (LIFO) stack. The arithmetic and logic unit performs ADD, AND, OR and exclusive OR operations on true and complemented data from the registers at nearly 10^6 operations per second. A shifter is provided for single bit left or right shifts and an I/O data multiplexer for communication with an external data bus. Control is provided over a 4-bit, time multiplexed command bus.

The RALU operates on +5V and −12V supplies with 4-phase, non-overlapping clocks. Signals which are intended for interface with the MM5751 CROM are MOS level, while those which are intended for interface with the rest of the processor system are TTL levels.

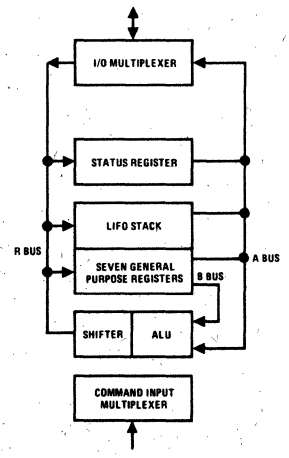
features

■ 4-bit slice of register and arithmetic logic block	Expandable to 32-bit word
■ Arithmetic and logic operations	ADD, AND, OR, Exclusive OR
■ 7 general purpose registers	Functions not pre-assigned
■ 4-bit status register	Overflow, Link, Carry, general flag
■ 16 word stack	Last in, first out
■ Multiplexed I/O data bus	4-bit, bipolar compatible
■ Multiplexed command bus	4-bit MOS levels
■ High speed operation	~ 700 kHz
■ Standard supplies	+5V, −12V
■ Bipolar compatibility	Drives TTL
■ 4-phase clock	Non-overlapping
■ Standard package	24-pin DIP

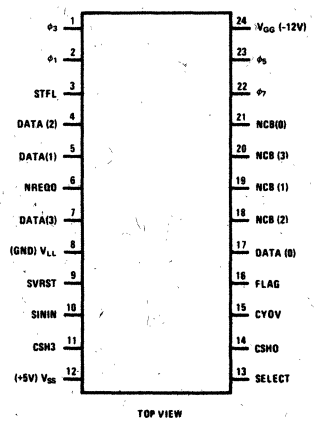
applications

- General purpose processor
- Distributed and multiprocessors
- Process controllers
- Machine tool controllers
- Small business machines
- Terminal controllers
- Test system and instrument control
- Traffic controller

block and connection diagrams



Dual-In-Line Package



TOP VIEW

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absolute maximum ratings

All Input or Output Voltages With Respect to Most Positive Supply Voltage V_{SS}	+0.3V to −20V
Operating Temperature Range	0°C to +70°C
Storage Temperature	−65°C to +150°C
Power Dissipation	1W Maximum at +25°C

Note: Maximum ratings indicate limits beyond which permanent damage may occur. Continuous operation at these limits is not intended and should be limited to those conditions specified under dc electrical characteristics.

dc electrical characteristics

(T_A = 0°C to +70°C, V_{SS} = +5V ±5%, V_{GG} = −12V ±5%, V_{LL} = GND)

PARAMETER	CONDITIONS	MIN (Note 2)	TYP	MAX (Note 2)	UNITS
Logic "1" Input (MOS and TTL) ($V_{IN(1)}$) (Note 1)		V_{SS} − 0.8			V
Logic "0" Input (MOS) ($V_{IN(0)}$)				V_{SS} − 7.0	V
Logic "0" Input (TTL) ($V_{IN(0)}$)				V_{SS} − 4.2	V
Logic "0" Input Current (TTL) ($I_{IN(0)}$)	V_{IN} = 0V			−1.75	mA
Input Leakage Current (MOS) (I_L)	V_{IN} = +5.0V to −12V			2	μA
Logic "1" Output (MOS) ($V_{OUT(1)}$)		V_{SS} − 0.7			V
Logic "0" Output (MOS) ($V_{OUT(0)}$)		V_{SS} − 8.0			V
Logic "1" Output (TTL) ($V_{OUT(1)}$)	I_{OUT} = 0.2 mA	2.4			V
Logic "0" Output (TTL) ($V_{OUT(0)}$)	I_{OUT} = −1.6 mA			0.4	V
Pull-up Transistor "on" Resistance ($P_{PULL-UP}$) (Note 1)	V_{IN} = V_{SS} − 1.0V	3.0		5.0	kΩ
Signal Line Input Capacitance (C_S) for SELECT, SVRST, SININ, DATA (0), (1), (2), (3)	V_{IN} = V_{SS}, f_T = 700 kHz		7.0	10	pF
CSH0, CSH3 Input Capacitance (C_S)	V_{IN} = V_{SS}, f_T = 700 kHz		11	14	pF
Clock Input Capacitance (C_C)	V_{IN} = V_{SS}, f_T = 700 kHz	30	40	55	pF
Clock "1" Level ($V_{\phi(1)}$) (Note 4)		V_{SS} − 1.0		V_{SS}	V
Clock "0" Level ($V_{\phi(0)}$)		V_{GG}		V_{GG} + 1.0	V
Load Capacitance for DATA(0), (1), (2), (3), CSH0, CSH3 (C_L)	V_{IN} = 0V, f_T = 700 kHz			25	pF
CYOV, FLAG				20	pF
STFL, NREQ0				30	pF
Current Sinking Resistors Required on CYOV, STFL, NREQ0 (R_{SINK}) (Note 3)	From Pin to V_{GG}	4.6		5.8	kΩ
Power Dissipation (P_D) (T_1 − T_8 Equal Width)	f = 700 kHz		600	800	mW

Note 1: Internal pull-up provided for TTL inputs. Refer to Figure 3 and text.
Note 2: Max = most positive; Min = most negative.
Note 3: Required to drive 74H loads. Larger resistance values may be used to drive standard or low power TTL.
Note 4: Clamp diodes and series damping resistors may be required to prevent clock overshoot.

FUNCTIONAL DESCRIPTION OF RALU

A diagram of the RALU is shown in Figure 1. Seven general registers (labelled R_1−R_7) are provided. Any of the seven registers may be loaded onto the A- or B-bus for processing by the arithmetic and logic unit (ALU). The data on the A-bus may be complemented before being loaded on the IA-bus, which serves as the input to the ALU. The operations which may be performed by the ALU are ADD, AND, OR and exclusive OR. The ADD operation adds IA and B and the carry (CSH0) from pin 14. A carry output (CSH3) is provided by pin 11. The result of the ALU operation is available to the shifter via the S-bus. The shifter provides a one bit left or right shift (or no shift) and transfers the shift information in and out of pins 11 and 14. Output data from the shifter may be returned to any of the registers over the R-bus.

A 16 word last in, first out stack (LIFO) is provided and may be accessed over the A- and R-buses. When the bottom word of the stack becomes non-zero a stack full signal (STFL) is provided at pin 3. Status information is provided by a 4-bit status register. Link, Overflow, Carry and Flag indicators are provided in bit positions 3, 2, 1 and 0 respectively (where bit 3 is the most significant bit). The Link flag may be included in shift operations (under control of the Select input) and the Overflow and Carry flags provide information on the result of ADD operations. A general purpose status flag (Flag) is also provided which may be used for interrupt enable or other functions where it is desirable to save status bits on the stack. Also, the Link, Overflow and Carry functions may be disabled, allowing these flags to be used for general purpose application. This is

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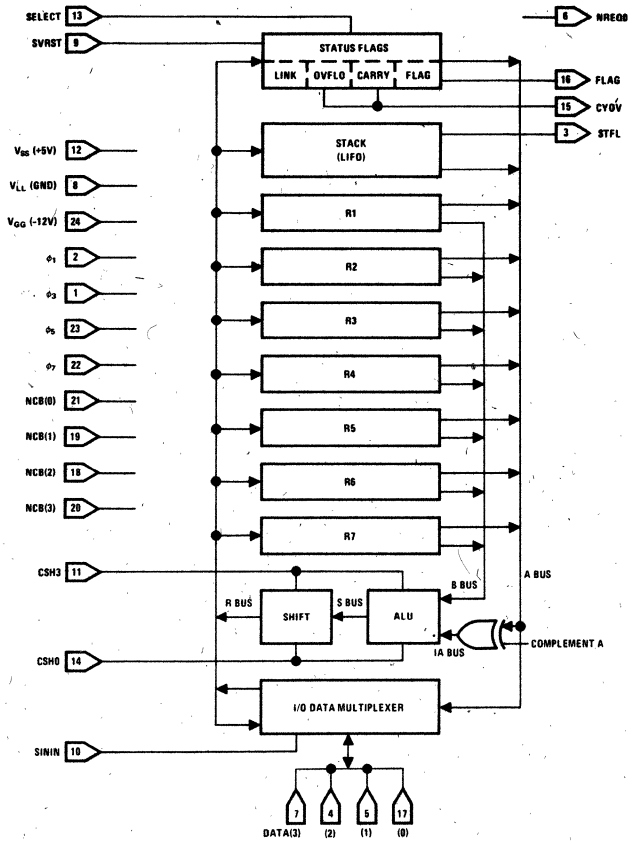

FIGURE 1. RALU Block Diagram

described in the section detailing control signals for the RALU.

Communication between the RALU and the rest of the system is provided by the I/O data multiplexer. This logic provides for loading the R-bus from the external data bus, as well as sending data from the A- and R-buses. Details of signal functions and timing are presented in the following sections. Positive true logic signals are used ("1" = most positive voltage, "0" = most negative voltage). Signal names beginning with N are complemented signals.

FUNCTIONAL DESCRIPTION OF SIGNALS

Signal timing for the RALU is shown in Figure 2. The timing diagram is divided into 8 time intervals (T_1-T_8) based on the 4-phase non-overlapping clocks. The clock inputs have MOS levels of +5V and −12V and occur during the odd time intervals. Thus phase 1 clock is a logic "0" (−12V) during T_1 and a logic "1" (+5V) during T_2-T_8.

Commands

The command inputs to the RALU occur on pins 21, 19, 18, and 20 which correspond to command bits NCB(0), (1), (2), and (3) respectively. The command inputs are complemented MOS signals and are multiplexed over the 4 odd time intervals in each RALU cycle (T_1, T_3, T_5, T_7). The inputs must be driven negative to logic "0" during the even time intervals. The command functions for each bit are indicated in the diagram. During T_1, the three least-significant command bits specify the address of the register (R_1-R_7) to be loaded on the A-bus. If NCB(0), (1), and (2) are all logic "1" the A-bus is set equal to zero. The fourth command bit NCB(3) is used to enable stack operations. If NCB(3) is at a logic "1" (most positive level) no stack operations occur. If it is a logic "0" stack operations are enabled, but will only occur if the A or R-bus address is zero. If the A-bus address is zero the stack will be pulled onto the A-bus. If the R-bus address is zero, the R-bus will be pushed onto the stack.

During T_3 the three least-significant bits specify the address of the register (R_1-R_7) to be loaded on the B-bus. (Note that stack and flags cannot be accessed over the B-bus. An address of zero always gives zero data, however, NCBX's = all 1's.) The most-significant bit specifies that the A-bus is to be complemented when it is transferred to the IA-bus.

During T_5, NCB(1) and NCB(0) specify the ALU operation to be performed as follows: 00-AND, 01-XOR, 10-OR, 11-ADD. NCB(3) and NCB(2) are used to specify control functions as follows: 00-No-OP, 01-R-bus control, 10-shift S-bus left 1-bit position during transfer to R-bus, 11-shift S-bus right 1-bit position during transfer to R-bus.

The R-bus control code is used in conjunction with the I/O control bit (NCB(3) at T_7) and the Byte input (SININ at T_5) to set the value of the R-bus as shown below and in Table I (RALU command code summary).

During T_7 the three least significant bits specify the address of the register (R_1-R_7) to be loaded

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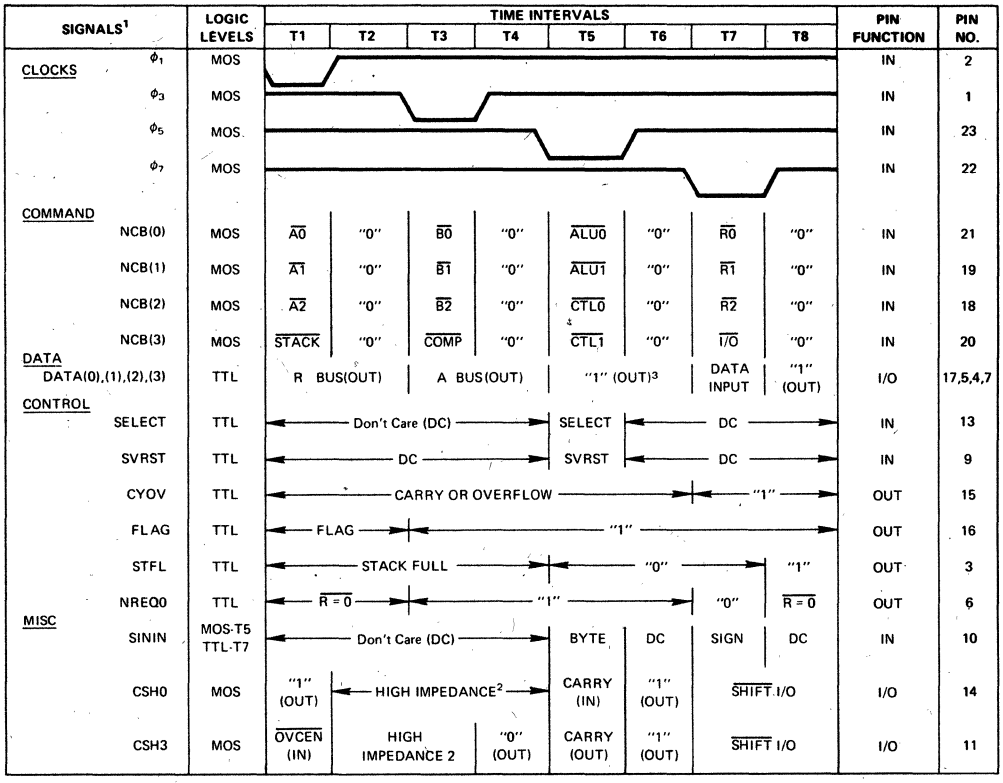

Note 1: A positive true logic convention is used for all signals (i.e., "1" = more positive voltage, "0" = more negative voltage). Signal names beginning with N are complemented signals.

Note 2: CSH0 and CSH3 high impedance state for intervals T_2 through T_4 is the TRI-STATE mode for output drivers.

Note 3: "1" (OUT) means RALU is driving this node to the "1" logic level during the defined interval. For bidirectional I/O lines the logic state is defined as "in" or "out."

FIGURE 2. RALU Timing Diagram

from the R-bus. The most-significant bit specifies that the R-bus is to be set equal to the output of the I/O multiplexer rather than the shifter (unless R-bus control was specified at T_5). Reference R-bus control states Table I.

Data

The data transfers between the RALU and memory or peripheral devices occur on pins 17, 5, 4, and 7 which correspond to data bits DATA(0), (1), (2) and (3) respectively. During T_1 and T_2 the data lines are driven with the value of the R-bus which occurred at the end of the *previous timing cycle.* This output may be used by the CROM chip for conditional branch inputs. During T_3 and T_4 the data lines are driven with the value that was loaded onto the A-bus during the current timing cycle. This output is typically used for address and data output to system memory or peripheral devices. During T_5 and T_6 the data lines are driven to a logic "1." During T_7 the data lines are used for input to the RALU from system memory or peripheral devices. *The data receivers are "zeroes catching" so the data lines must not be allowed to go negative during T_7 unless the data input is to be a logic zero.* During T_8 the data lines are again driven to a logic "1" by the RALU. As with all TTL inputs on the RALU a 3K–5K pull-up is provided on the chip to insure an adequate logic "1" level (see Figure 3). The pull-up is provided by an MOS transistor which is turned on only during the data input interval. At other times it is in the "off" or high impedance state.

Control Signals

The RALU control lines provide a means of using the RALU status flags. The SELECT line is used as an input at T_5 ("zeroes catching") and is unused at other times. If the SELECT line is a logic "1" at T_5 the Overflow status flag will be selected as the output on the Carry or Overflow (CYOV) line (pin 15) during the *following* cycle. If the RALU is in the most significant byte of a processor (as specified by the Byte input on the SININ line) the Link status flag will be included in any shift that occurs in the current cycle. The shift will be a five (5) bit shift with the Link in the most significant bit position. If the Select input is a logic "0" at T_5 the Carry status flag will be selected at the CYOV output and shift operations will not affect the Link.

The Save/Restore (SVRST) line is used as an input during T_5 ("zeroes catching") and provides a means of modifying the status flags over the data bus. If SVRST is a logic "1" during T_5 the status flags will be loaded onto the A-bus during the *following cycle (at T_1),* provided the A-bus address bits NCB(2), (1), and (0), at T_1 during that cycle are a logic "1." If a pull stack operation has been specified by NCB(3), (2), (1), and (0) at T_1, the SVRST input at T_7 will inhibit it and instead the status flags will be loaded on the A-bus. Table II specifies the control bits and the data that occurs on the A-bus at T_1. The SVRST line also causes the status flags to be loaded from the R-bus at the end of the following cycle. (The status of

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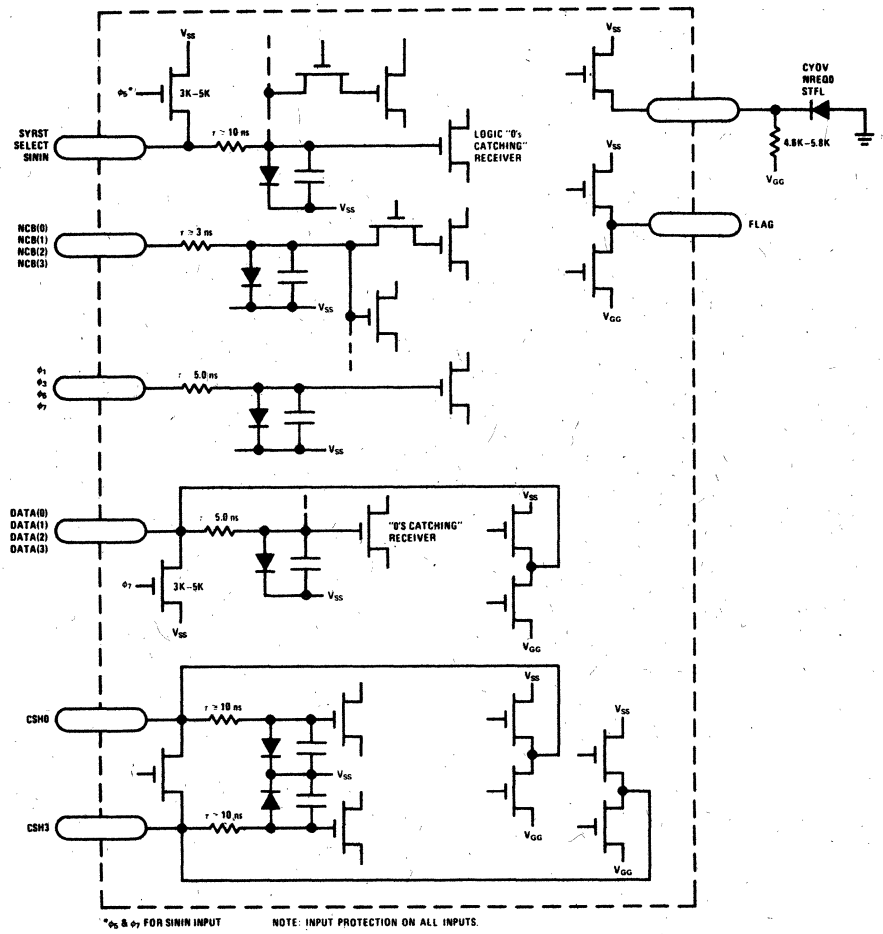

FIGURE 3. RALU Driver and Receiver Buffers

SVRST during *one cycle* only affects conditions in the *following cycle.*) This will occur in parallel with the loading of any other register specified by the R-bus address. Table III specifies the control bits and the results that occur on the R-bus.

The CYOV line provides an output signal indicating the state of the Carry or Overflow status flag as determined by the Select input. The Flag output indicates the state of the general purpose status flag. The stack full (STFL) output goes true when the bottom word of the stack is non-zero *at the start of the preceding cycle.* The result bus equals zero (NREQ0) output goes to logic "0" level when the R-bus contains all zeroes. The CYOV, STFL and NREQ0 outputs require an external resistor connected to V_{GG}.

Miscellaneous Signals

The SININ line is used to input information as to whether the RALU is in the most or least significant byte of a processor word (at T_5) and also the sign value which is propagated to the most significant byte (at T_7) when the R-bus control function is specified. If SININ is a logic "1" at T_5 the RALU will enable the functions of the most significant byte. The functions enabled are inclusion of the Link in shift operations and setting the R-bus to zero or sign as specified by the R-bus control code. If SININ at T_5 is a logic "0" the functions are not enabled.

The carry input (CSH0) and carry output (CSH3) lines are used primarily for transfer of carry and shift information between RALU's or between RALU and CROM. If an ADD operation is specified, the value of carry input (CSH0) at T_5 will be added to the IA and B-bus inputs to the ALU. The resulting carry output from the most significant bit will occur on CSH3 at T_5. When a left shift is specified, the shift output from the most significant bit occurs on CSH3 at T_7 and T_8 while the shift input ("zeroes catching") to the least significant bit must be provided on CSH0 during T_7 and T_8. The pins exchange roles for a right shift. During T_1 the CSH3 input (if a logic "0" at T_1) is used to enable the Overflow and Carry flags to be set to the result of an ADD operation, *if an ADD is specified for the current cycle.* The Carry flag is set equal to the value of the ripple carry out of the most significant bit of the ALU. The Overflow flag is set if there is a two's complement arithmetic overflow (i.e. sign of both operands was the same and the sign of the result is different). For systems using multiple RALU's the Overflow and Carry flags of all but the most significant RALU will be disabled by the logic "1" output of CSH0 generated by the adjacent RALU at T_1. These flags may therefore be used for general purpose functions.

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TABLE I. RALU Commands

1.A Command Inputs

COMMAND BITS[1]

TIME INTERVAL	NCB(3)	NCB(2)	NCB(1)	NCB(0)
T1	STACK	← A BUS →		
T3	COMP	← B BUS →		
T5	← CTL →		← ALU →	
T7	I/O	← R BUS →		

1.B Command Codes[3]

ALU FUNCTIONS

NCB(1), (0) @ T5	FUNCTION
11	AND
10	XOR
01	OR
00	ADD

CTL FUNCTIONS

NCB(3), (2) @ T5	FUNCTION
11	NONE
10	R BUS CONTROL
01	SHIFT LEFT
00	SHIFT RIGHT

A, B & R BUS ADDRESSES

NCB(2), (1), (0)	ADDRESS
111	ZEROES, FLAGS, STACK[2]
110	R1
101	R2
100	R3
011	R4
010	R5
001	R6
000	R7

R BUS CONTROL

I/O (NCB(3) @ T7)	BYTE (SININ @ T5)	R BUS VALUE
1	0	OUTPUT OF SHIFTER
1	1	OUTPUT OF SHIFTER
0	0	OUTPUT OF I/O MUX
0	1	VALUE OF SIGN INPUT ON SININ @ T7

Note 1: Commands are complemented signals.
Note 2: See text and Tables II and III for addressing flags and stack. B bus only addresses zeroes.
Note 3: Logic values shown are values which must be applied to NCB inputs to get indicated results.

TABLE II. Binary Table for A Bus Addressing (Time Interval T_1)

INPUTS		RESULTING DATA ON A BUS
SVRST @ Previous Cycle T_5	NCB (3), (2), (1), (0) @ Current Cycle T_1	
0	1 1 1 1	All Zero's
0	1 1 1 0	Contents of R_1
0	1 1 0 1	Contents of R_2
0	1 1 0 0	Contents of R_3
0	1 0 1 1	Contents of R_4
0	1 0 1 0	Contents of R_5
0	1 0 0 1	Contents of R_6
0	1 0 0 0	Contents of R_7
0	0 1 1 1	Pull Stack
0	0 1 1 0	Contents of R_1
0	0 1 0 1	Contents of R_2
0	0 1 0 0	Contents of R_3
0	0 0 1 1	Contents of R_4
0	0 0 1 0	Contents of R_5
0	0 0 0 1	Contents of R_6
0	0 0 0 0	Contents of R_7
1	1 1 1 1	Status Flags
1	1 1 1 0	Contents of R_1
1	1 1 0 1	Contents of R_2
1	1 1 0 0	Contents of R_3
1	1 0 1 1	Contents of R_4
1	1 0 1 0	Contents of R_5
1	1 0 0 1	Contents of R_6
1	1 0 0 0	Contents of R_7
1	0 1 1 1	Status Flags
1	0 1 1 0	Contents of R_1
1	0 1 0 1	Contents of R_2
1	0 1 0 0	Contents of R_3
1	0 0 1 1	Contents of R_4
1	0 0 1 0	Contents of R_5
1	0 0 0 1	Contents of R_6
1	0 0 0 0	Contents of R_7

Note: Logic values shown are what must be applied to NCB (which is a complemented signal) to get desired results.

TABLE III. Binary Table for R Bus Addressing (Time Interval T_7)

INPUTS		REGISTER LOADED FROM R BUS
SVRST @ Previous Cycle T_5	NCB (3) @ Current Cycle T_1 and NCB (2), (1), (0) @ Current Cycle T_7	
0	1 1 1 1	Not Stored
0	1 1 1 0	R_1
0	1 1 0 1	R_2
0	1 1 0 0	R_3
0	1 0 1 1	R_4
0	1 0 1 0	R_5
0	1 0 0 1	R_6
0	1 0 0 0	R_7
0	0 1 1 1	Push Stack
0	0 1 1 0	R_1
0	0 1 0 1	R_2
0	0 1 0 0	R_3
0	0 0 1 1	R_4
0	0 0 1 0	R_5
0	0 0 0 1	R_6
0	0 0 0 0	R_7
1	1 1 1 1	Status Flags
1	1 1 1 0	Status Flags and R_1
1	1 1 0 1	Status Flags and R_2
1	1 1 0 0	Status Flags and R_3
1	1 0 1 1	Status Flags and R_4
1	1 0 1 0	Status Flags and R_5
1	1 0 0 1	Status Flags and R_6
1	1 0 0 0	Status Flags and R_7
1	0 1 1 1	Status Flags and Push Stack
1	0 1 1 0	Status Flags and R_1
1	0 1 0 1	Status Flags and R_2
1	0 1 0 0	Status Flags and R_3
1	0 0 1 1	Status Flags and R_4
1	0 0 1 0	Status Flags and R_5
1	0 0 0 1	Status Flags and R_6
1	0 0 0 0	Status Flags and R_7

Note: Logic values shown are what must be applied to NCB inputs to get results shown.

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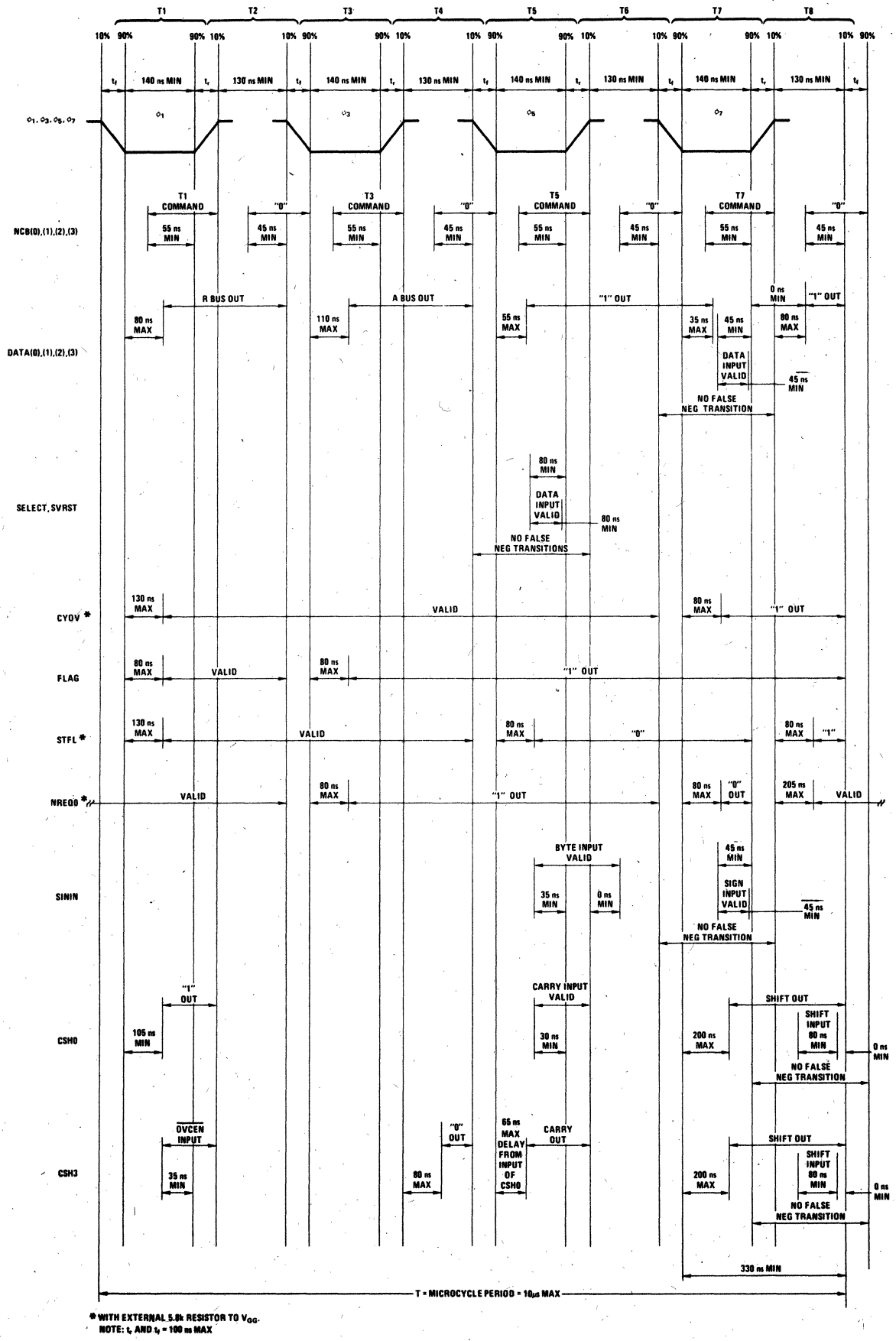

* WITH EXTERNAL 5.0k RESISTOR TO V_{GG}.
NOTE: t_r AND t_f = 100 ns MAX

FIGURE 4. RALU Signal Timing Specifications

(T_A = 0°C to +70°C, V_{SS} = +5.0V ±5%, V_{GG} = −12V ±5%, V_{LL} = GND)

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Recommended Start-up Conditions

Power supplies must be within specification for ten microseconds (10μs) before clocks are started. (Note: All internal nodes must be in a discharged state before start-up.) When power supplies are cycled on and off rapidly the nodes must be discharged by running the clocks for one (1) microcycle (T_1-T_8) after power is removed from the RALU. An internal initialize pulse causes the status flags, registers and the stack to be cleared at power on.

It is recommended that STFL and CYOV be tied to V_{SS} if not used.

SIGNAL TIMING SPECIFICATIONS

The timing specifications for all RALU signals are shown in Figure 4. These specifications apply over the complete range of recommended operating conditions (T_A = 0°C to +70°C, V_{SS} = +5V ±5%, V_{GG} = −12V ±5%). Time intervals are defined with respect to the 10% and 90% points of the four MOS clock inputs. The clocks have a maximum rise and fall times of 100 ns. The command inputs on the NCB lines must be valid a minimum of 55 ns prior to the end of the odd time intervals (see Figure 3). Data inputs to the RALU over the data lines must be valid for at least 35 ns during T_7 and *must never go falsely negative to a logic zero, during T_7, due to the "zeroes catching" nature of the receiver.* It will often simplify interface design if input data to the RALU is gated onto the data bus during parts of T_6 and T_8 as well as during the required interval T_7. The logic "1" outputs of the RALU data lines at T_6 and T_8 may be overridden by the data input drive; however, the increased power dissipation will lower the maximum allowable ambient temperature for the chip. (Note: The logic "1" output drive has a minimum impedance of 300Ω to V_{SS}.)

The specification of the carry output (CSH3) applies only when the carry input to CSH0 is valid prior to the start of T_5. If the CSH0 input is not valid at the start of T_5 then the CSH3 output will become valid a maximum of 65 ns after the input becomes valid. In a typical 16-bit application the carry input (CSH0) to the least significant RALU will be valid at the start of T_5, however, the carry input to the more significant RALU's will be delayed, since it must first be generated at the CSH3 output of the preceding less significant RALU.

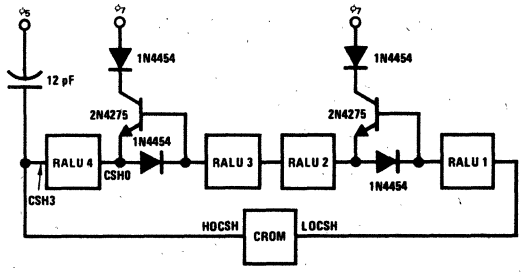
As indicated on the CSH0 timing specification, the latest the CSH0 input can become valid for a proper RALU ADD operation to occur is 30 ns before the end of T_5.

The output from CSH3 is valid within 65 ns of a valid input at CSH0. In a system with multiple RALU's the carry must propagate through each RALU and provide a valid input to the most significant RALU at least 30 ns before the end of T_5. For a system with N RALU's, the minimum width of T_5 to allow for carry propagation is 30 + 65N ($N \leq 8$). However, this is strongly affected by the carry line capacitance (this capacitance should be minimized as much as possible, especially for the high order bits).

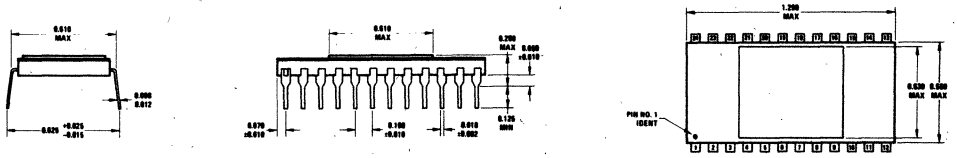
For systems where N is large, T_5 should be streched to provide the additional time. Alternatively the buffer circuit shown in the figure below may be used between RALU's. A single buffer between the center RALU's will typically reduce the carry propagation time by about 20%, however the noise margin is reduced somewhat.

Two carry speed up circuits may be used to allow operation of a 16-bit system at a 1.4μs microcycle time. The degradation of the carry signal's logic "1" level with two speed up circuits may be significant under adverse conditions. A simple circuit to improve this situation consists of a small capacitor (12 pF) between the ϕ_5 clock and the carry line out of the high order RALU (HOCSH).

A 16-bit system using two speed up circuits with the compensating capacitor is shown below. The minimum width of T_5 for this 16-bit system is 170 ns (valid over 0°C to +70°C).



physical dimensions



Cavity Dual-In-Line Package (D)
Order Number IMP-00H/520D

Manufactured under one or more of the following U.S. patents: 3083262, 3189758, 3231797, 3303356, 3317671, 3323071, 3381071, 3408542, 3421025, 3426423, 3440498, 3518750, 3519897, 3557431, 3560765, 3566218, 3571630, 3575609, 3579059, 3593069, 3597640, 3607469, 3617859, 3631312, 3633052, 3638131, 3648071, 3651565, 3693248.

National Semiconductor Corporation
2900 Semiconductor Drive, Santa Clara, California 95051, (408) 737-5000/TWX (910) 339-9240
National Semiconductor GmbH
808 Fuerstenfeldbruck, Industriestrasse 10, West Germany, Tele. (08141) 1371/Telex 05-27649
National Semiconductor (UK) Ltd.
Larkfield Industrial Estate, Greenock, Scotland, Tele. (0475) 33251/Telex 778-632

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INS4001 ROM & I/O port, INS4002-1 RAM, INS4003 shift register INS4004 CPU, four-bit integrated processing system INS4008/INS4009 in a four-bit integrated processing system (FIPS)

general description

FIPS is a four-bit, general-purpose microprocessor chip set designed for application in intelligent terminals, traffic signals, measuring instruments, numeric control and process control systems. It interfaces easily with switches, keyboards, displays, and other peripheral devices; and it provides a compact and powerful replacement for random logic in many control systems.

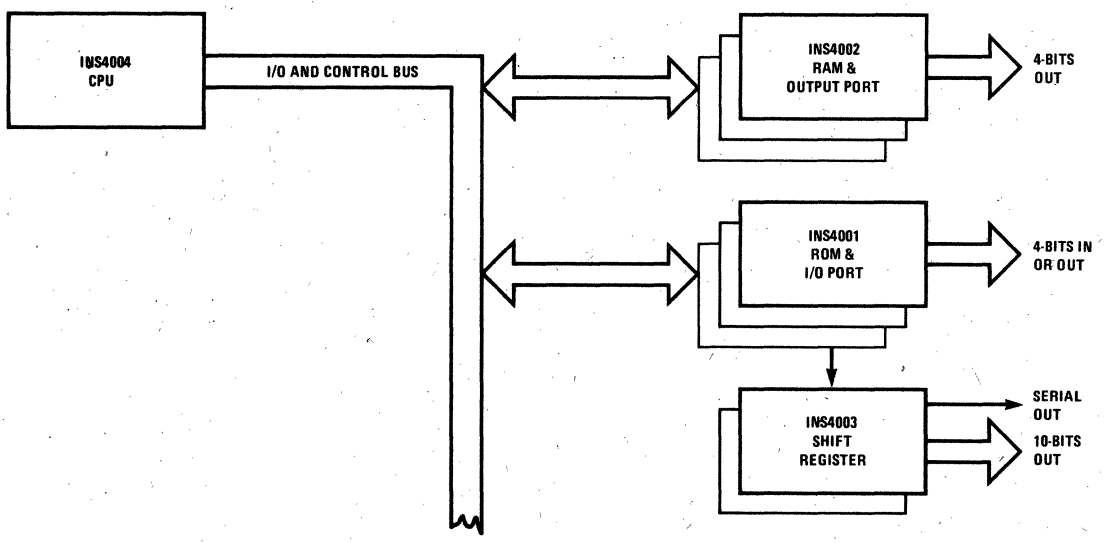
INS4002, INS4003, and INS4004 are standard building blocks for system control, I/O, and temporary data storage. The INS4001 ROM is mask-programmed to customer specifications and holds the application program for the FIPS controller. The FIPS microprocessor can interface directly with up to 4K x 8 of ROM, 1280 x 4 RAM, and 128 I/O lines. A small amount of additional logic will interface FIPS with up to 48 RAM or ROM packages in any combination, and 192 I/O lines. The minimum system configuration consists of one CPU and one ROM.

The National Semiconductor FIPS microprocessor is fabricated from PMOS, Silicon-gate technology for high reliability and producibility. Its powerful instruction set includes binary and decimal arithmetic, conditional branch, and indirect addressing instructions.

features

- General purpose programmable microprocessor
- 45 instructions, including:
  - Conditional Branch
  - Indirect Fetch
  - Binary/Decimal Arithmetic
- Easy memory expansion to 32K bits of ROM and 4K bits of RAM
- 16-pin dual in-line package allows compact designs
- Parallel operation for higher performance
- Simple memory and I/O interface for low system cost
- Second source for the MCS-4* microprocessor chips 4001, 4002-1, 4002-2, 4003, and 4004

block diagram-FIPS microprocessor chip set



*MCS-4 is a registered trademark of INTEL Corp.

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INS4001 256×8 bit mask-programmed ROM and 4-bit I/O port

The INS4001 is a 2K metal-mask ROM which interfaces directly to the INS4004 CPU and is used to store the control program for the FIPS system. Its address decoding capability is also used to control the selection of a built-in 4-bit I/O port. Data is transferred between the ROM and the CPU via a time-multiplexed, 4-bit Data Bus.

ROM OPERATION

During ROM access, 12-bit addresses and 8-bit data words are multiplexed onto the 4-bit Data Bus connecting the INS4001 with the CPU. (See FIPS Basic Instruction Cycle Timing Diagram). During the three address periods following a SYNC command from the CPU, addresses which select one of 256 words per ROM, and one of 16 ROM chips, are passed to the INS4001. During the next two time periods, 8 bits of instruction are transferred from the ROM to the CPU. A command signal (CM) is provided from the CPU, and is used to select a ROM bank (group of 16 ROMs).

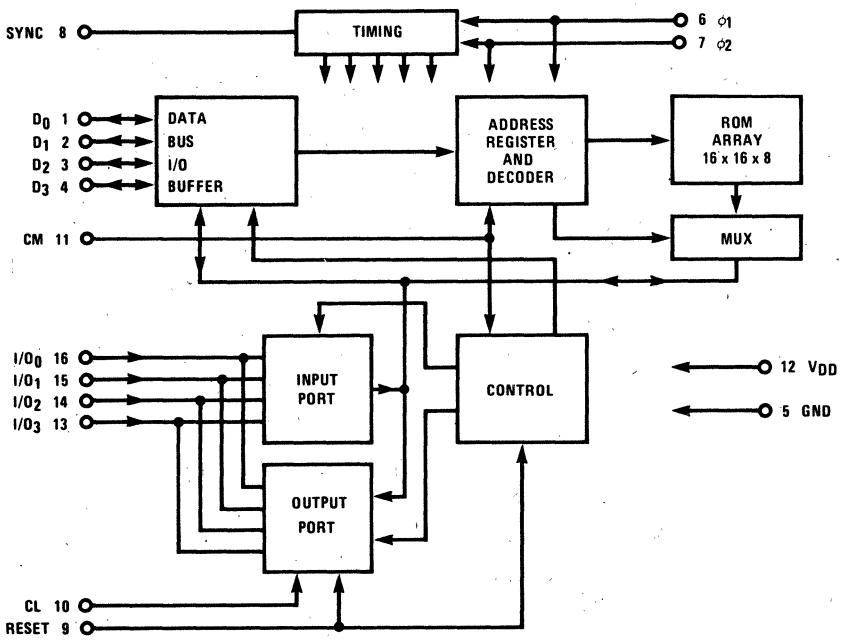
I/O PORT OPERATION

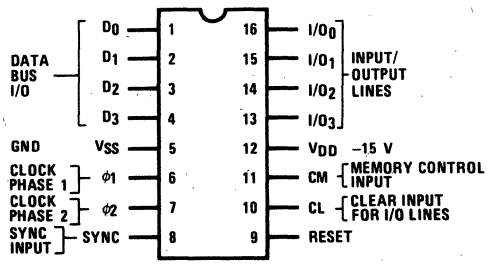
In this mode of operation, the chip routes data directly between the Data Bus and a 4-bit I/O port which is part of the chip. Each chip has the capability to identify itself for I/O operations, and to recognize and execute I/O commands from the CPU. An external signal (CL) may be applied to asynchronously clear the output register during normal operation.

All internal flip-flops will be reset when the RESET line goes low (negative voltage).

Each I/O pin can be selected as an input or output line by metal mask option. Inputs and outputs may be selected as direct or inverted. An on-chip resistor tying the inputs to either V_{DD} or V_{SS} is also optional.

block and connection diagrams





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INS4002 320-bit RAM and 4-bit output port

The INS4002 combines the functions of 4-bit parallel read/write data storage and 4-bit output/control lines which facilitate data transfer between the CPU and a peripheral device.

RAM OPERATION

RAM storage in the INS4002 is organized as 4 registers of 20 4-bit characters each (16 main memory and 4 status characters). Main memory locations are selected during an SRC instruction, while status locations are selected during the actual I/O or RAM instruction.

When doing a RAM data transfer, the CPU first executes an SRC instruction, which sends out the contents of the designated index register pair (X_2 X_3) as an address to the RAM. These bits are decoded as shown in the diagram below.

X_2				X_3			
D_3	D_2	D_1	D_0	D_3	D_2	D_1	D_0
Chip # (0-3)		Register # (0-3)		Main Memory Character # (0-15)			

Selection of different RAM chips is based upon a metal-mask address option (INS4002-1 or INS4002-2) and an external pin, P_O, which may be wired to either V_{DD} or V_{SS}. Decoding is as shown below:

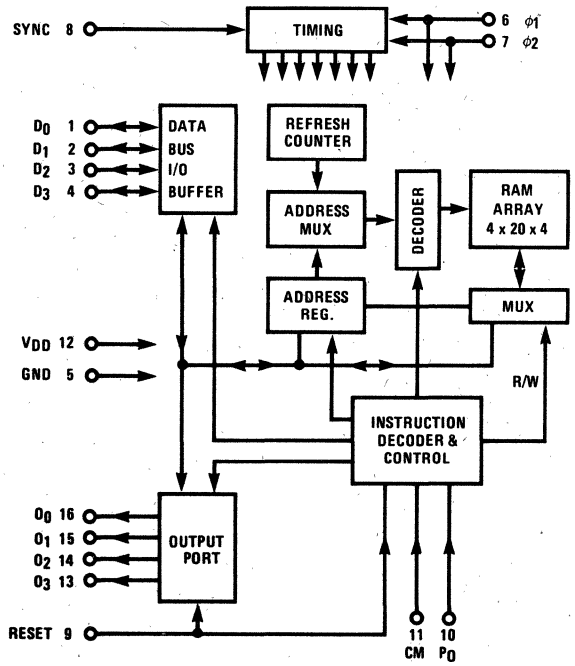
CHIP #	OPTION	P_O	D_3	D_2
0	INS4002-1	GND	0	0
1	INS4002-1	V_{DD}	0	1
2	INS4002-2	GND	1	0
3	INS4002-2	V_{DD}	1	1

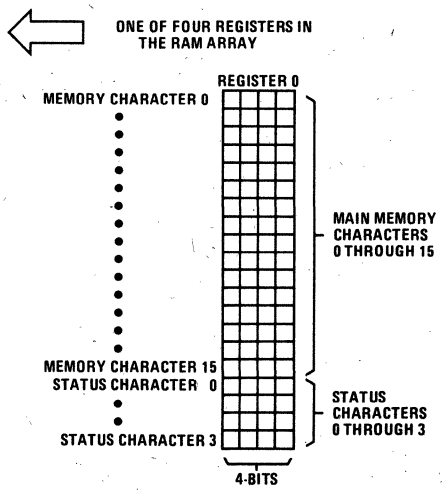
Timing is based upon two externally-supplied clock signals, and a SYNC signal provided by the CPU. Internal refresh circuitry maintains memory data in the cells of the chip.

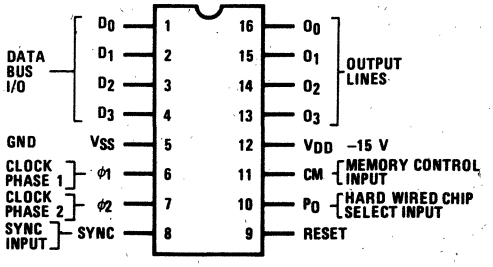
OUTPUT PORT OPERATION

The INS4002 has the capability to transfer data directly from the system Data Bus through a 4-bit Output Port to an external peripheral device. When the external RESET line goes low, the memory and all static flip-flops are cleared. To completely clear memory, the RESET line must be held low for at least 32 memory cycles (32 x 8 clock periods).

block and connection diagrams







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INS4003 10-bit serial-in/parallel-out shift register

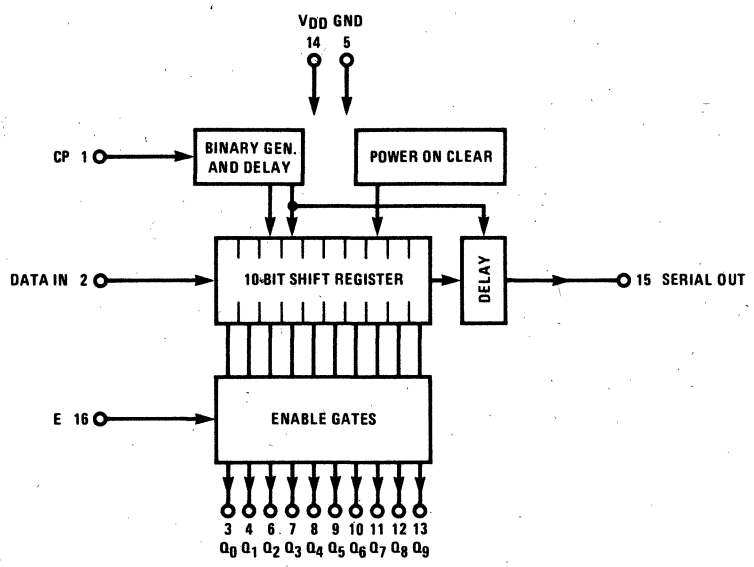
The INS4003 10-bit static shift register is used to increase the number of output lines available from the microprocessor system to interface with peripheral devices.

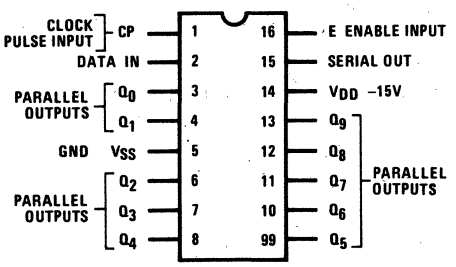
Data is loaded serially into the Shift Register, and is then available in parallel on 10 output lines which can be accessed through enable logic. When the ENABLE line (E) is low, shift register contents are available at pins Q_0 - Q_9. When E is high, these pins are at V_{SS}.

A Serial-Data-Out line is also available from the Shift Register, and it allows an indefinite number of Shift Registers to be cascaded together to provide any required number of output lines, in multiples of 10. This serial output line is not affected by the E line.

Data is clocked through the Shift Register by a signal on the CP line. An internal initialization circuit clears the shift register between the application of the supply voltage and the first CP signal.

block and connection diagrams





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INS4004 4-bit central processing unit (CPU)

The INS4004 is the Central Processing Unit of the FIPS microprocessor system. It includes the necessary control logic to request program instructions from main memory (INS4001 ROMs), decode the instructions and execute them. It is designed to interface directly with the INS4001, INS4002, and INS4003 chips. Communication with the outside world is accomplished through I/O ports included in these chips.

The CPU itself consists of a 4-bit ALU, 16 4-bit index registers, a 12-bit program counter (PC), three levels of PC stack, an instruction register, and miscellaneous control logic. Communication with other chips is accomplished over a time-multiplexed 4-bit Data Bus.

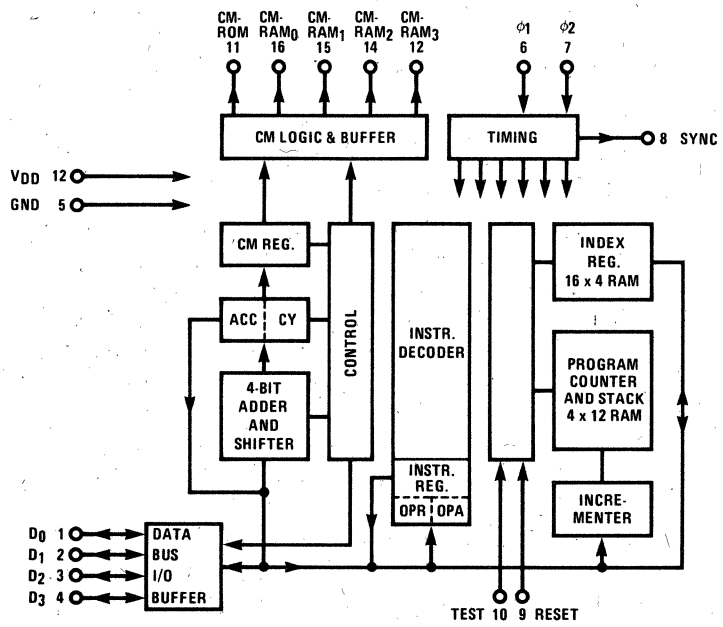
In operation, the CPU sends a SYNC signal to the ROMs and RAMs in the system, followed by 12 bits of address data (during the next three clock cycles), to select the next instruction to be executed. The selected ROM sends back 8 bits of instruction during the following two clock times, and this information is stored in the OPR and OPA registers within the CPU. The CPU executes the instruction during the next three clock times.

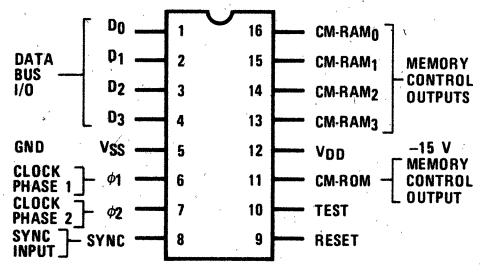
CPU instructions are drawn from the INS4001 ROMs, arranged in banks of 16 ROMs each. Bank switching is done under program control, with the CPU selectively enabling one bank of ROMs to fetch an instruction.

The CPU provides a Conditional Jump instruction which is used to test an external input pin. A RESET signal may be supplied to the CPU to clear all registers and flip-flops. After RESET, the program will start from step "0," executing program instructions.

The INS4004 CPU provides a total of 45 program instructions, which are specified in the table on the following page.

block and connection diagrams





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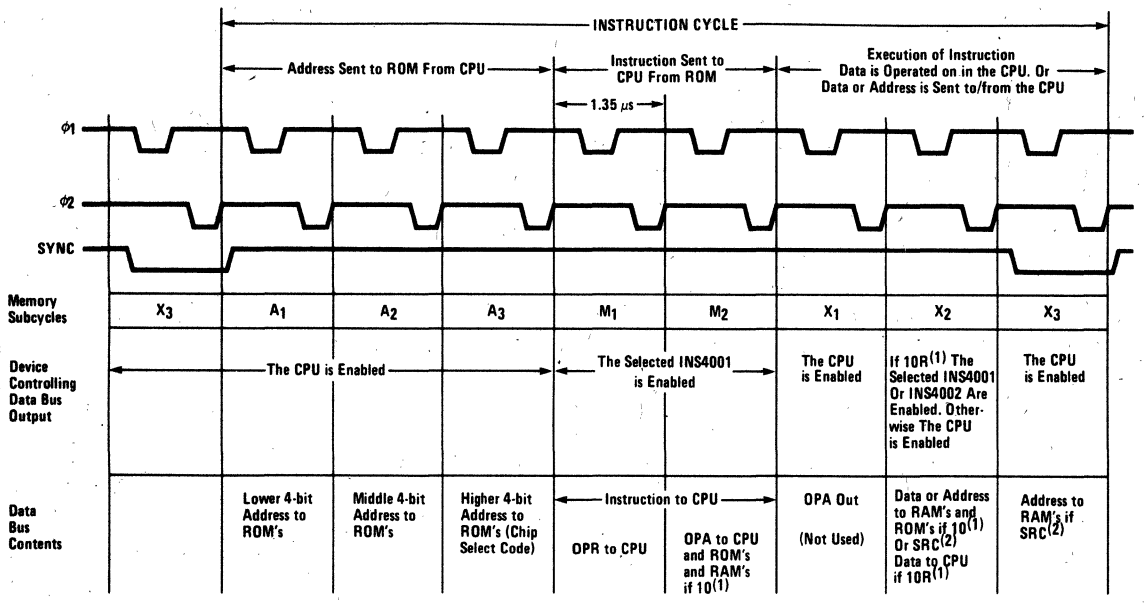
system timing



FIPS Basic Instruction Cycle

instruction set

[Those instructions preceded by an asterisk (*) are 2 word instructions that occupy 2 successive locations in ROM]

MACHINE INSTRUCTIONS

MNEMONIC	OPR	OPA	DESCRIPTION OF OPERATION
NOP	0 0 0 0	0 0 0 0	No operation.
*JCN	0 0 0 1 A_2 A_2 A_2 A_2	C_1 C_2 C_3 C_4 A_1 A_1 A_1 A_1	Jump to ROM address A_2 A_2 A_2 A_2, A_1 A_1 A_1 A_1 (within the same ROM that contains this JCN instruction) if condition C_1 C_2 C_3 C_4(1) is true, otherwise skip (go to the next Instruction in sequence).
*FIM	0 0 1 0 D_2 D_2 D_2 D_2	R R R 0 D_1 D_1 D_1 D_1	Fetch immediate (direct) from ROM Data D_2, D_1 to index register pair location RRR.(2)
SRC	0 0 1 0	R R R 1	Send register control. Send the address (contents of index register pair RRR) to ROM and RAM at X_2 and X_3 time in the Instruction Cycle.
FIN	0 0 1 1	R R R 0	Fetch indirect from ROM. Send contents of index register pair location 0 out as an address. Data fetched is placed into register pair location RRR.
JIN	0 0 1 1	R R R 1	Jump indirect. Send contents of register pair RRR out as an address at A_1 and A_2 time in the Instruction Cycle.
*JUN	0 1 0 0 A_2 A_2 A_2 A_2	A_3 A_3 A_3 A_3 A_1 A_1 A_1 A_1	Jump unconditional to ROM address A_3, A_2, A_1.
*JMS	0 1 0 1 A_2 A_2 A_2 A_2	A_3 A_3 A_3 A_3 A A A A	Jump to subroutine ROM address A_3, A_2, A_1, save old address. (Up 1 level in stack.)
INC	0 1 1 0	R R R R	Increment contents of register RRRR.(3)
*ISZ	0 1 1 1 A_2 A_2 A_2 A_2	R R R R A_1 A_1 A_1 A_1	Increment contents of register RRRR. Go to ROM address A_2, A_1 (within the same ROM that contains this ISZ instruction) if result ≠ 0, otherwise skip (go to the next instruction in sequence).
ADD	1 0 0 0	R R R R	Add contents of register RRRR to accumulator with carry.
SUB	1 0 0 1	R R R R	Subtract contents of register RRRR to accumulator with borrow.
LD	1 0 1 0	R R R R	Load contents of register RRRR to accumulator.
XCH	1 0 1 1	R R R R	Exchange contents of index register RRRR and accumulator.
BBL	1 1 0 0	D D D D	Branch back (down 1 level in stack) and load data DDDD to accumulator.
LDM	1 1 0 1	D D D D	Load data DDDD to accumulator.

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input/output and RAM instructions

[The RAM's and ROM's operated on in the I/O and RAM instructions have been previously selected by the last SRC instruction executed.]

MNEMONIC	OPR	OPA	DESCRIPTION OF OPERATION
WRM	1 1 1 0	0 0 0 0	Write the contents of the accumulator into the previously selected RAM main memory character.
WMP	1 1 1 0	0 0 0 1	Write the contents of the accumulator into the previously selected RAM output port. (Output Lines)
WRR	1 1 1 0	0 0 1 0	Write the contents of the accumulator into the previously selected ROM output port. (I/O Lines)
WRϕ[4]	1 1 1 0	0 1 0 0	Write the contents of the accumulator into the previously selected RAM status character 0.
WR1[4]	1 1 1 0	0 1 0 1	Write the contents of the accumulator into the previously selected RAM status character 1.
WR2[4]	1 1 1 0	0 1 1 0	Write the contents of the accumulator into the previously selected RAM status character 2.
WR3[4]	1 1 1 0	0 1 1 1	Write the contents of the accumulator into the previously selected RAM status character 3.
SBM	1 1 1 0	1 0 0 0	Subtract the previously selected RAM main memory character from accumulator with borrow.
RDM	1 1 1 0	1 0 0 1	Read the previously selected RAM main memory character into the accumulator.
RDR	1 1 1 0	1 0 1 0	Read the contents of the previously selected ROM input port into the accumulator. (I/O Lines)
ADM	1 1 1 0	1 0 1 1	Add the previously selected RAM main memory character to accumulator with carry.
RDϕ[4]	1 1 1 0	1 1 0 0	Read the previously selected RAM status character 0 into accumulator.
RD1[4]	1 1 1 0	1 1 0 1	Read the previously selected RAM status character 1 into accumulator.
RD2[4]	1 1 1 0	1 1 1 0	Read the previously selected RAM status character 2 into accumulator.
RD3[4]	1 1 1 0	1 1 1 1	Read the previously selected RAM status character 3 into accumulator.

accumulator group instructions

CLB	1 1 1 1	0 0 0 0	Clear both. (Accumulator and carry)
CLC	1 1 1 1	0 0 0 1	Clear carry.
IAC	1 1 1 1	0 0 1 0	Increment accumulator.
CMC	1 1 1 1	0 0 1 1	Complement carry.
CMA	1 1 1 1	0 1 0 0	Complement accumulator.
RAL	1 1 1 1	0 1 0 1	Rotate left. (Accumulator and carry)
RAR	1 1 1 1	0 1 1 0	Rotate right. (Accumulator and carry)
TCC	1 1 1 1	0 1 1 1	Transmit carry to accumulator and clear carry.
DAC	1 1 1 1	1 0 0 0	Decrement accumulator.
TCS	1 1 1 1	1 0 0 1	Transfer carry subtract and clear carry.
STC	1 1 1 1	1 0 1 0	Set carry.
DAA	1 1 1 1	1 0 1 1	Decimal adjust accumulator.
KBP	1 1 1 1	1 1 0 0	Keyboard process. Converts the contents of the accumulator from a one out of four code to a binary code.
DCL	1 1 1 1	1 1 0 1	Designate command line.

NOTES: (1) The condition code is assigned as follows:

$C_1 = 1$ Invert jump condition
$C_1 = 0$ Not invert jump condition
$C_2 = 1$ Jump if accumulator is zero
$C_3 = 1$ Jump if carry/link is a 1
$C_4 = 1$ Jump if test signal is a 0

(2) RRR is the address of 1 of 8 index register pairs in the CPU.

(3) RRRR is the address of 1 of 16 index registers in the CPU.

(4) Each RAM chip has 4 registers, each with twenty 4-bit characters subdivided into 16 main memory characters and 4 status characters. Chip number, RAM register and main memory character are addressed by an SRC instruction. For the selected chip and register, however, status character locations are selected by the instruction code (OPA).

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absolute maximum ratings

Ambient Temperature Under Bias	0°C to +70°C
Storage Temperature	−55°C to +150°C
Input Voltages and Supply Voltage with Respect to V_{SS}	+0.5 to −20 V
Power Dissipation	1.0 W

***Note 1:** "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

d.c. and operating characteristics

T_A = 0°C to +70°C; V_{DD} = −15 V ±5%, V_{SS} = GND, $t_{\phi PW}$ = $t_{\phi D1}$ = 400 ns, $t_{\phi D2}$ = 150 ns, unless otherwise specified. Logic "0" is defined as the more positive voltage (V_{IH},V_{OH}), Logic "1" is defined as the more negative voltage (V_{IL}, V_{OL}).

PRODUCT	SYMBOL	PARAMETER	LIMIT MIN.	LIMIT TYP.(1)	LIMIT MAX.	UNIT	TEST CONDITIONS
SUPPLY CURRENT							
INS4001	I_{DD1}	Average Supply Current		15	30	mA	T_A = 25°C
INS4002	I_{DD2}	Average Supply Current		17	33	mA	T_A = 25°C
INS4003	I_{DD3}	Average Supply Current		5.0	8.5	mA	t_{WL} = t_{WH} = 8 μsec; T_A = 25°C
INS4004	I_{DD4}	Average Supply Current		30	40	mA	T_A = 25°C
INPUT CHARACTERISTICS(ALL INPUTS EXCEPT I/O INPUT PINS)							
INS4001/2/4	I_{LI}	Input Leakage Current			10	μA	V_{IL} = V_{DD}
INS4001/2/4	V_{IH}	Input High Voltage (Except Clocks)	V_{SS}−1.5		V_{SS}+0.3	V	
INS4001/2/4	V_{IL}	Input Low Voltage (Except Clocks)	V_{DD}		V_{SS}−5.5	V	
INS4001/2/4	V_{ILC}	Clock Input Low Voltage	V_{DD}		V_{SS}−13.4	V	
INS4001/2/4	V_{IHC}	Clock Input High Voltage	V_{SS}−1.5		V_{SS}+0.3	V	
OUTPUT CHARACTERISTICS (ALL OUTPUTS EXCEPT I/O OUTPUT PINS)							
INS4001/2/4	I_{LO}	Data Bus Output Leakage Current			10	μA	V_{OUT} = −12V, Chip disabled
INS4001/2/4	V_{OH}	Output High Voltage		V_{SS}	V_{SS}−0.5	V	Driving 4000 Series loads only
INS4001/2/4	I_{OL1}	Data Lines Sinking Current "1" Level	10	18		mA	V_{OUT} = 0V
INS4004	I_{OL5}	CM-ROM Sinking Current "1" Level	6.5	12		mA	V_{OUT} = 0V
INS4004	I_{OL6}	CM-RAM Lines Sinking Current "1" Level	2.5	4		mA	V_{OUT} = 0V
INS4001/2/4	V_{OL1}	Data Lines, CM Lines, Sync Output Low Voltage	V_{SS}−12	V_{SS}−10	V_{SS}−6.5	V	I_{OL1} = 500 μA
INS4001/2/4	R_{OH1}	Output Resistance Data Data Lines "0" Level		150	250	Ω	V_{OUT} = 0.5 V
INS4004	R_{OH5}	CM-ROM Output Resistance "0" Level		320	600	Ω	V_{OUT} = −0.5 V
INS4004	R_{OH6}	CM-RAM Lines Output Resistance "0" Level		1.1	1.8	KΩ	V_{OUT} = −0.5 V
I/O INPUT CHARACTERISTICS							
INS4001/3	I_{LI}	Input Leakage Current			10	μA	V_{IL} = V_{DD}
INS4001/3	V_{IH}	Input High Voltage	V_{SS}−1.5		V_{SS}+0.3	V	
INS4001/3	V_{IL}(2)	Input Low Voltage	V_{DD}		V_{SS}−4.2	V	
INS4001	R_I	I/O Pins Input Resistance	10	18	35	KΩ	Internal input resistor is optional
I/O OUTPUT CHARACTERISTICS							
INS4001/2	I_{OL2}	I/O Output Line Sinking Current, "1" Level	2.5	5		mA	V_{OUT} = 0V. For T^2L compatibility a 12KΩ (±10%) resistor between output and V_{DD} should be added(3).
INS4003	I_{OL3}	Parallel Out Pins Sinking Current, "1" Level	0.6	1.0		mA	V_{OUT} = 0V. For T^2L compatibility a 5.6KΩ (±10%) resistor between output and V_{DD} should be added(3).
INS4003	I_{OL4}	Serial Out Sinking Current, "1" Level	1.0	2.0		mA	V_{OUT} = 0V
INS4001/2	V_{OL2}	I/O Output Lines Output Low Voltage	V_{SS}−12	V_{SS}−7.5	V_{SS}−6.5	V	I_{OL2} = 50 μA
INS4003	V_{OL3}	Output Low Voltage	V_{SS}−11	V_{SS}−7.5	V_{SS}−6.5	V	I_{OL3} = 10 μA
INS4001/2	R_{OH2}	Output Resistance I/O Lines "0" Level		1.2	1.8	KΩ	V_{OUT} = −0.5 V
INS4003	R_{OH3}	Parallel-Out Pins Output Resistance "0" Level		400	750	Ω	V_{OUT} = −0.5 V
INS4003	R_{OH4}	Serial Out Output Resistance "0" Level		650	1200	Ω	V_{OUT} = −0.5 V

Note 1: Typical values are for T_A = 25°C and Nominal Voltages.
Note 2: If non-inverting input option is used, V_{IL} = −6.5 Volts maximum.
Note 3: For T^2L compatibility on the I/O lines the supply voltages should be V_{DD} = −10 V ±5%, V_{SS} = +5 V ±5%.

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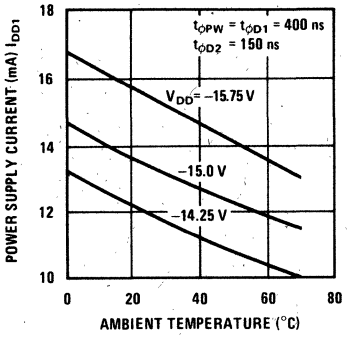
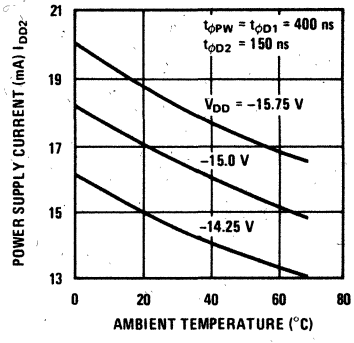
typical d.c. characteristics

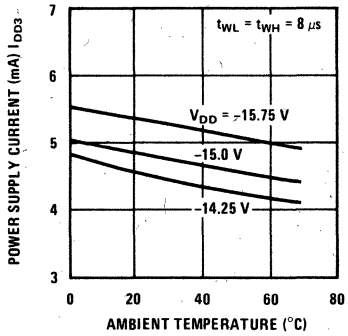
Power Supply Current vs Temperature (INS4001)



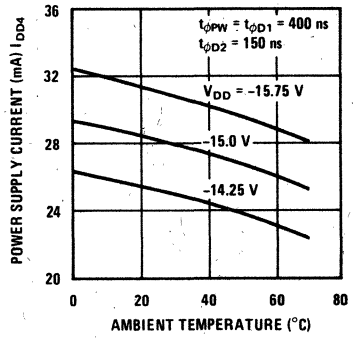
Power Supply Current vs Temperature (INS4002)



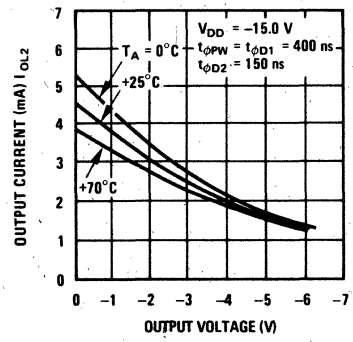
Power Supply Current vs Temperature (INS4003)



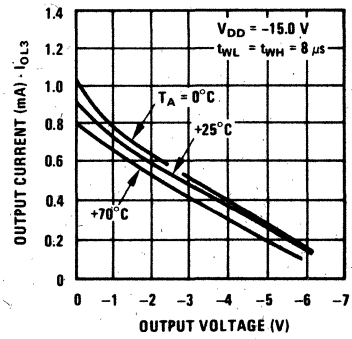
Power Supply Current vs Temperature (INS4004)



Output Current vs Output Voltage (INS4001, INS4002)



Output Current vs Output Voltage (INS4003)



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system timing instruction set T_A = 0°C to +70°C; V_{DD} = −15 V ±5%, V_{SS} = GND

PRODUCT	SYMBOL	TEST	LIMIT MIN.	LIMIT MAX.	UNIT	CONDITIONS
INS4001/2/4	t_{cy}	Clock Period	1.35	2	μs	
	$t_{\phi R}$ $t_{\phi F}$	Clock Rise and Fall Times		50	ns	
	$t_{\phi PW}$	Clock Width	380	480	ns	
	$t_{\phi D1}$	Clock Delay from ϕ_1 to ϕ_2	400	550	ns	
	$t_{\phi D2}$	Clock Delay from ϕ_2 to ϕ_1	150		ns	
	t_W	Data-In Write Time	350		ns	
	t_H	Data-In Hold Time	40		ns	
	t_{OS}(1)	Set Time for Data Out, SYNC, CM-ROM, (2)CM-RAM, (2)Lines	0		ns	C_{OUT} = 500 pF for data lines 500 pF for SYNC 160 pF for CM.ROM 50 pF for CM-RAM
	t_{OH}	Holdtime for Data Out, Sync, CM-ROM, CM-RAM Lines	50		ns	C_{OUT} = 20 pF
	$t_R t_F$	Rise and Fall Times for Data Out, SYNC, CM-ROM, CM-RAM Lines		500	ns	C_{OUT} = 500 pF for data lines 500 pF for SYNC 160 pF for CM-ROM 50 pF for CM-RAM
INS4001/2	t_D	I/O Output Lines Delay		600	ns	C_{OUT} = 20 pF
	t_{WC}	CM Write Time	350		ns	
	t_{HC}	CM Hold Time	10		ns	
INS4001	t_{IS}	I/O Input Lines Set Time	50		ns	
	t_{IH}	I/O Input Lines Hold Time	100			
	t_C(3)	I/O Output Lines Delay on Clear		200	ns	C_{OUT} = 20 pF

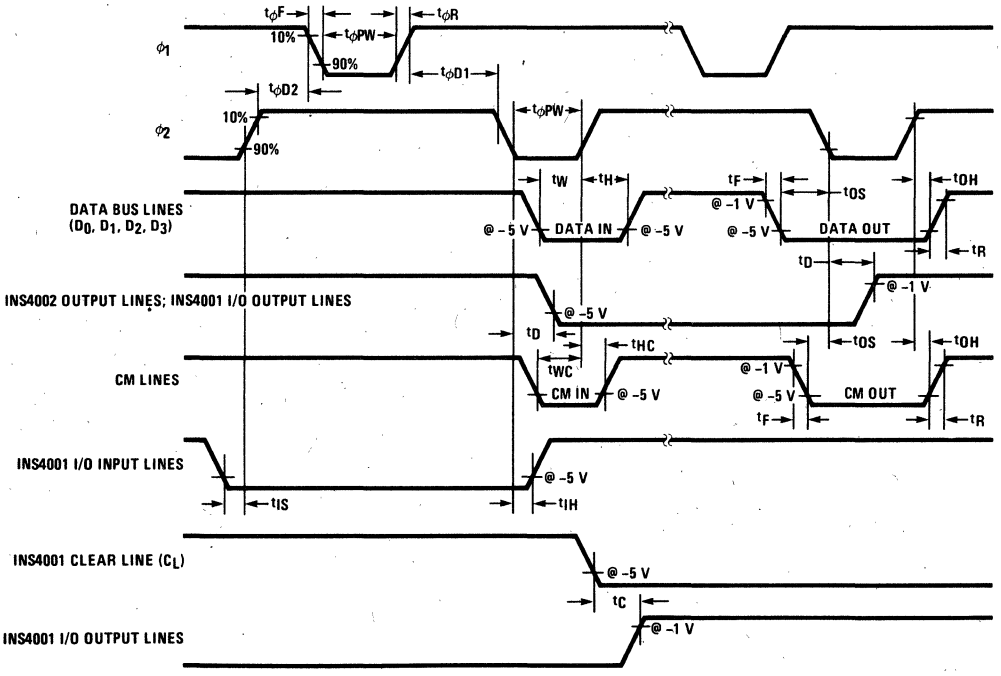
NOTES:

(1) Date out, SYNC, CM-ROM, and CM-RAM lines are clocked out with the trailing edge of the ϕ_2 clock.

(2) The CM-ROM and the selected CM-RAM lines are always activated during A_3 time. They are also activated during M_2 time if an I/O and RAM instruction was fetched by the CPU, and during X_2 time if an SRC instruction was fetched by the CPU;

(3) Pin C_L on INS4001 is used to asynchronously clear the output flip-flops associated with the I/O lines.

INS4001,INS4002,INS4004 timing diagram



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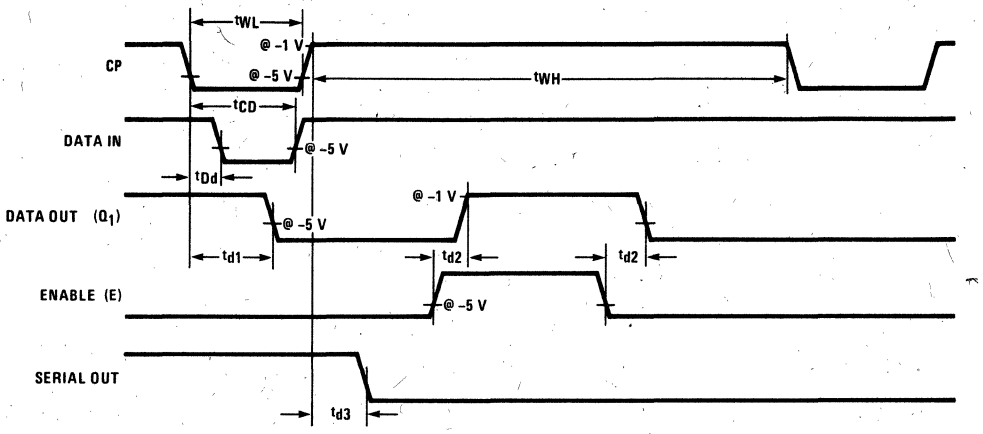
INS4003 a.c. characteristics $T_A = 0°C$ to $+70°C$; $V_{DD} = -15 \pm 5\%$, V_{SS} = GND

SYMBOL	TEST	LIMIT MIN.	LIMIT MAX.	UNIT	CONDITIONS
t_{WL}	CP Low Width	6	10,000	μs	
t_{WH}	CP High Width	6	Note (1)	μs	
t_{CD}	Clock-On to Data-Off Time	3		μs	
t_{Dd}	CP to Data Set Delay	Note (2)	250	ns	
t_{d1}	CP to Data Out Delay	250	1,750	ns	
t_{d2}	Enable to Data Out Delay		350	ns	C_{OUT} = 20 pF
t_{d3}	CP to Serial Out Delay	200	1,250	ns	C_{OUT} = 20 pF

NOTES: (1) t_{WH} can be any time greater than 6 μsec.
(2) Data can occur prior to CP.

INS4003 timing diagram



capacitance f = 1 MHz; V_{IN} = 0 V; T_A = 25°C; Unmeasured Pins Grounded.

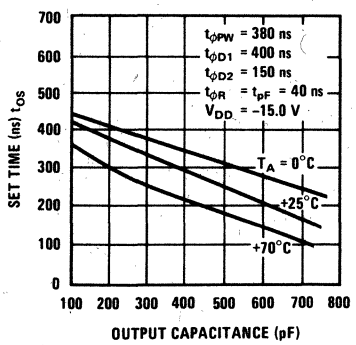
PRODUCT	SYMBOL	TEST	LIMIT (pF) TYP.	LIMIT (pF) MAX.
INS4001/2/3/4	C_{IN}	Input[1] Capacitance	5	10
INS4001/2	$C_{\phi 1}$, $C_{\phi 2}$	Clock Input Capacitance	8	15
INS4004	$C_{\phi 1}$, $C_{\phi 2}$	Clock Input Capacitance	14	20

PRODUCT	SYMBOL	TEST	LIMIT (pF) TYP.	LIMIT (pF) MAX.
INS4002/4	C_{D1}	Data Bus I/O Lines Capacitance	6.5	10
INS4001	C_{D2}	Data Bus I/O Lines Capacitance	9.5	15

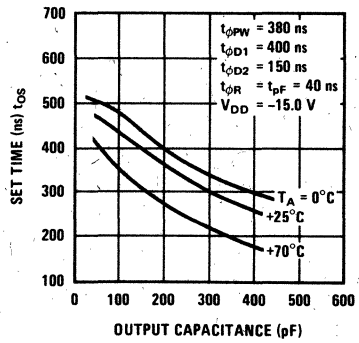
NOTE: (1) Refers to all input pins except data bus I/O and ϕ_1 and ϕ_2.

typical load characteristics

Set Time vs Output Capacitance (Data Lines for INS4001, INS4002, INS4004 & Sync for INS4004)



Set Time vs Output Capacitance (CM-ROM INS4004)



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INS4008/INS4009 in a four-bit integrated processing system (FIPS)

The INS4008/4009 standard memory and I/O interface set provides the complete control functions performed by the INS4001. The INS4008/4009 are completely compatible with other members of the FIPS family. All activity is still under control of the INS4004 CPU. One set of INS4008/4009 and several TTL decoders are sufficient to interface to 4k words of program memory, sixteen four-bit input ports and sixteen four-bit output ports.

It should be noted that in any FIPS configuration the program memory is distinct from the read/write data storage (INS4002 RAM). Using the INS4008/4009, programs can now be stored and executed from RAM memory, but this RAM memory is distinct from the INS4002 read/write data storage. RAM program memory will be organized in eight bit words and 256 word pages, just like the memory array inside the INS4001. Any combination of PROM, ROM, and RAM will be referred to as program memory.

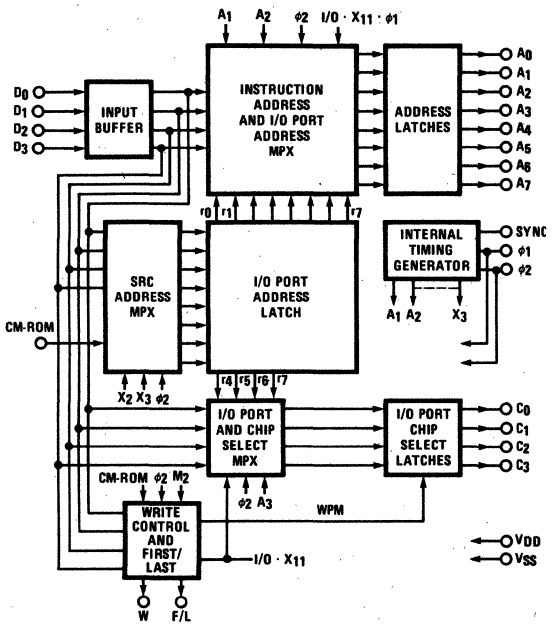
The accompanying diagrams show the internal organization of both the INS4008 and INS4009.

The INS4008 is the address latch chip which interfaces the INS4004 to standard PROMs, ROMs and RAMs used for program memory. The INS4008 latches the eight bit program address sent out by the CPU during A1 and A2 time. During A3 time it latches the ROM chip number from the INS4004. The eight bit program address is then presented at pins A0 through A7 and the four bit chip number (also referred to as page number) is presented at pins C0 through C3. These four bits must be decoded externally and one page of program memory is selected.

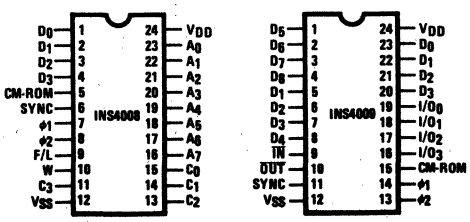
The INS4009 then transfers the eight bit instruction from program memory to the INS4004 four bits at a time at M1 and M2. The command signal sent by the CPU activates the INS4009 and initiates this transfer.

When the CPU executes an SRC (Send Register Control) instruction, the INS4008 responds by storing the I/O address in its eight bit SRC register. The content of this SRC register is always transferred to the address lines (A0 through A7) and the chip select lines (C0 through C3) at X1 time. The appropriate I/O port is then selected by decoding the chip select lines. The IN and OUT lines of the INS4009 indicate whether an input or output operation will occur.

The INS4009 is primarily an instruction and I/O transfer device. When the CPU executes an RDR (Read ROM Port) instruction, the INS4009 will send an input strobe (pin 9) to enable the selected input port. It also enables I/O input buffers to transfer the input data from the I/O bus to the data bus. When the INS4009 interprets a WRR (Write ROM Port) instruction, it transfers output data from the CPU to the I/O bus and sends an output strobe (pin 10) to enable the selected output port. A formerly undefined instruction is now used in conjunction with the INS4008/4009 to write data into the RAM program memory. This new instruction is called WPM (Write Program Memory – 1110 0011). When an instruction is to be stored in RAM program memory, it is written in two four-bit segments. The F/L signal from the INS4008 keeps track of which half is being written. When the CPU executes a WPM instruction, the chip select lines of the INS4008 are jammed with "1111". In the system design this should be designated as the RAM channel. The W line on the INS4008 is also activated by the WPM instruction. The previously selected SRC address on line A0 through A7 of the INS4008 becomes the address of the RAM word being written. By appropriately decoding the chip select lines, the W line, and F/L, the write strobes can be generated for the memory. The F/L line is initially high when power comes on. It then pulses low when every second WPM is executed. A high on the F/L line means that the first four bits are being written, and a low means that the last four bits are being written. The INS4009 transfers the segment of the instruction to the I/O bus at X2 of the WPM instruction. The SRC address sent to RAM is only 8 bits. When more than one page of RAM (256 bytes) is being written, an output port must be used to supply additional address lines for higher order addresses.



INS4008 BLOCK DIAGRAM



PIN CONFIGURATIONS

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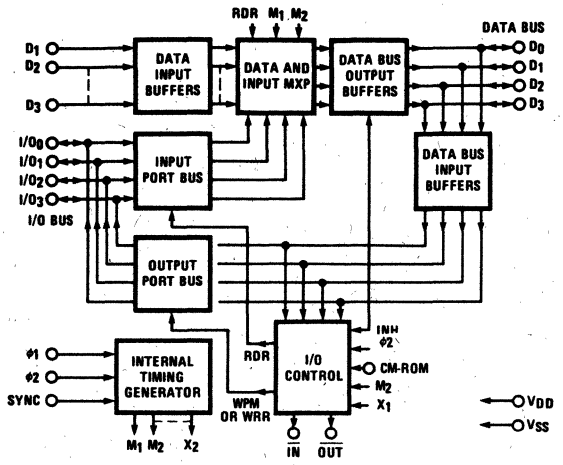

INS4009 BLOCK DIAGRAM

DEFINITION OF WRITE PROGRAM MEMORY INSTRUCTION

Mnemonic: WPM

OPR OPA: 1111 0011

Symbolic: 1111 → $C_3C_2C_1C_0$ of INS4008
ACC → $I/O_3I/O_2I/O_1I/O_0$ of INS4009
SRC Address → A_0 - A_7 of INS4008

Description: The chip select lines of the INS4008 are forced to "1111" at X1 time and the content of the accumulator is available on the INS4009 I/O bus at X2. RAM program memory can be loaded four bits at a time. The previous SRC address is sent out on lines A0 through A7 of INS4008.

SYSTEM ILLUSTRATIONS USING THE 4008 AND 4009

Example 1: Four MM1702A PROMs and Four I/O Ports. Four MM1702As are used for program storage and four four-bit I/O ports are used. In this case D-type output latches are used and a one of eight decoder 3205 is used to decode both the input and output strobes. Note that the I/O bus is buffered from the outputs. Buffers are needed only when the current sinking requirement on the bus exceeds 1.6 mA. In small systems low power TTL could be used and buffers could be avoided.

Example 2: Read/Write Memory for Program Storage. This example shows only the RAM portion of a system when RAM is used for program memory. Note that the chip selects are tied together in groups of four. The chip selects are gated with the F/L control line for writing only four bits at a time when executing a WPM instruction. They are also gated with the decoding of the chip selects from the INS4008 for normal program execution. The MM1101 (256 words x 1 bit) is shown. A similar system using the MM2102 (1k words x 1 bit) could be developed.

Example 3: Seven MM1702A PROMs, One RAM Block, and Seven I/O Ports. This example uses a single page of RAM program memory shown in Example 2 in a complete system. In this case the input ports are 8:1 multiplexers which are buffered from the I/O bus by a quad tri-state buffer. The input port selection is then the function of the multiplexers. The output ports are latches and the port selection is done using a DM74155 decoder.

Example 4: Eight MM1702A PROMs, Eight RAM Blocks, and Eight I/O Ports. Program memory organized with 2k bytes in ROM and 2k bytes in RAM. Each basic RAM block can be organized as in Example 2. When more than one block of RAM is used, the write chip select (WCS) for each RAM block is generated by properly gating chip select 15 with special decoding for page selection. Output port eight is dedicated to this selection function. This is only necessary when the RAM program memory is being written. In this example standard TTL logic elements are used for I/O port selection rather than decoders as shown in previous examples. In this case all input ports are tri-state buffers.

The following differences exist between a FIPS system using INS4001 program memory and a system using INS4008/4009 program memory:

1. For normal operation, INS4001 ROMs cannot be used in the same system with INS4008/4009.
2. Memory address, memory data, I/O bus, and control lines from both INS4008 and INS4009 are defined with respect to positive logic. The FIPS data and control lines from the INS4004 are defined with respect to negative logic. As a result, in program memory used with the INS4009, programs should be coded with logic "1" = high level and logic "0" = low level (i.e., NOP = 0000 0000 = NNNN NNNN). Note that programs are defined for the INS4001 in terms of negative logic such that NOP = 0000 0000 = PPPP PPPP. Carefully check all tapes submitted for metal mask ROMs to be sure that the correct logic definitions are used.
3. Input and output data from the INS4009 I/O bus is defined in terms of positive logic. If these interface devices are used for prototyping an INS4001 program memory, care should be taken to be sure that the I/O ports for the INS4001s are defined consistent with the INS4008/4009 system.
4. An I/O port associated with the INS4009 can have lines with both input and output capability. On the INS4001 each I/O line may have only a single function, either input or output.
5. The RAM program memory cannot be used as a substitute for the INS4002 read/write data storage. They perform distinctly different functions.
6. CM-ROM and CM-RAM_0 cannot be used to control INS4002s when CM-ROM is used for INS4008/4009 and the WPM instruction is being used. The reason is that the WPM instruction is interpreted as a Write Memory (WRM) by INS4002s connected to the same CM line as INS4008/4009. CM-RAM_0 in absence of a DCL behaves exactly like CM-ROM.

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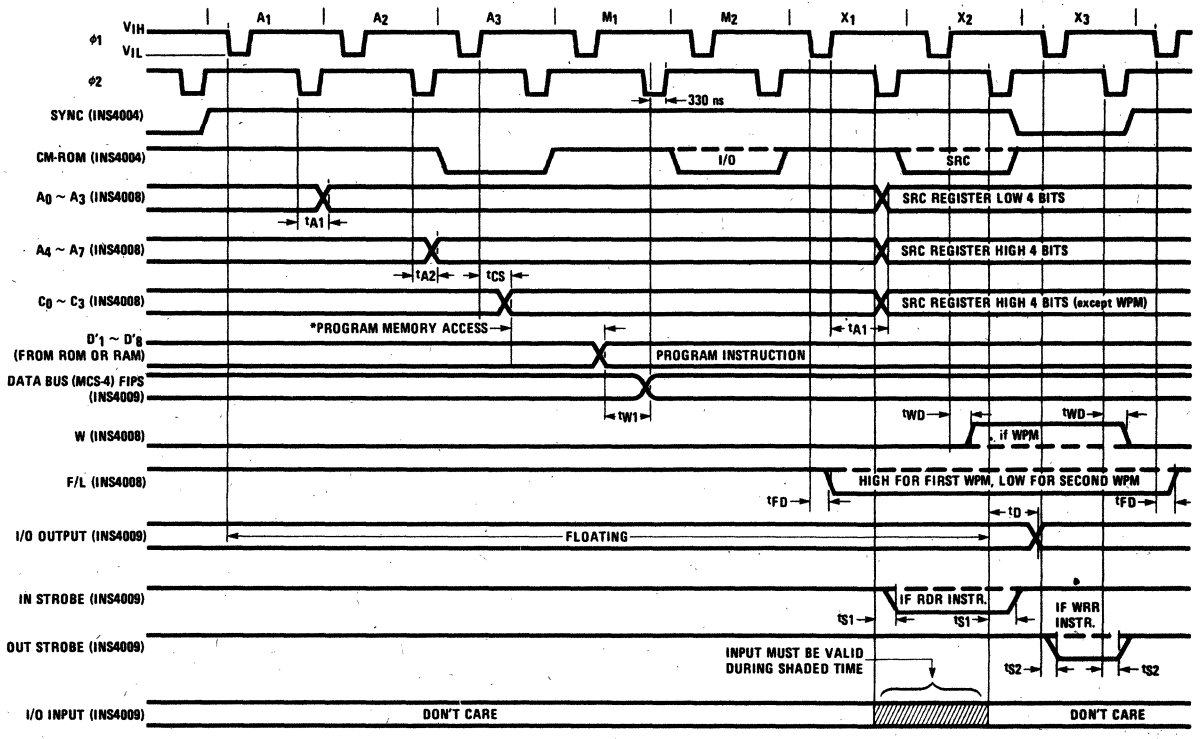
a.c. characteristics

T_A = 0°C to +70°C, V_{SS} - V_{DD} = 15 V ± 5%. All clock, sync, CM-ROM, data bus, and I/O timing specifications are identical with the INS4001 and INS4004.

Symbol	Parameter	Product	Limit		Unit	Test Conditions
			Min.	Max.		
t_{CY}	Clock Period	INS4008/4009	1.35	2.0	μs	
$t_{\phi R}$, $t_{\phi F}$	Clock Rise and Fall Time	INS4008/4009		50	ns	
$t_{\phi PW}$	Clock Width	INS4008/4009	380	480	ns	
$t_{\phi D1}$	Clock Delay from ϕ_1 to ϕ_2	INS4008/4009	400	500	ns	
$t_{\phi D2}$	Clock Delay from ϕ_2 to ϕ_1	INS4008/4009	150		ns	
t_{A1}	Address to Output Delay at A_1, X_1	INS4008		1	μs	C_L = 250 pF
t_{A2}	Address to Output Delay at A_2	INS4008		580	μs	C_L = 250 pF
t_{CS}	Chip Select Output Delay at A_3	INS4008		300	ns	C_L = 50 pF
t_{WD}	W Output Delay	INS4008		600	ns	C_L = 100 pF
t_{FD}	F/L Output Delay	INS4008	0.1	1	μs	C_L = 100 pF
t_{WI}	Data In Write Time	INS4009	470		ns	C_L = 200 pF on data bus
t_D	I/O Output Delay	INS4009		1.0	μs	C_L = 300 pF
t_{S1}	IN Strobe Delay	INS4009		450	ns	C_L = 50 pF
t_{S2}	OUT Strobe Delay	INS4009		1.0	μs	C_L = 50 pF

timing diagram



*PROGRAM MEMORY ACCESS TIME (CHIP SELECT TO DATA OUT) MUST BE LESS THAN OR EQUAL TO 900 ns.

capacitance

f = 1 MHz, V_{IN} = V_{SS}, T_A = +25°C.

Symbol	Parameter	Product	Limit (pF)		Symbol	Parameter	Product	Limit (pF)	
			Typ.	Max.				Typ.	Max.
C_{IN}	Input Capacitance	INS4008 INS4009	5 8	10 15	$C_{I/O}$	Data Bus and I/O Capacitance	INS4008/9	8	10
C_{OUT}	Output Capacitance	INS4008/9	8	10	C_ϕ	Clock Capacitance	INS4008/9	12	20

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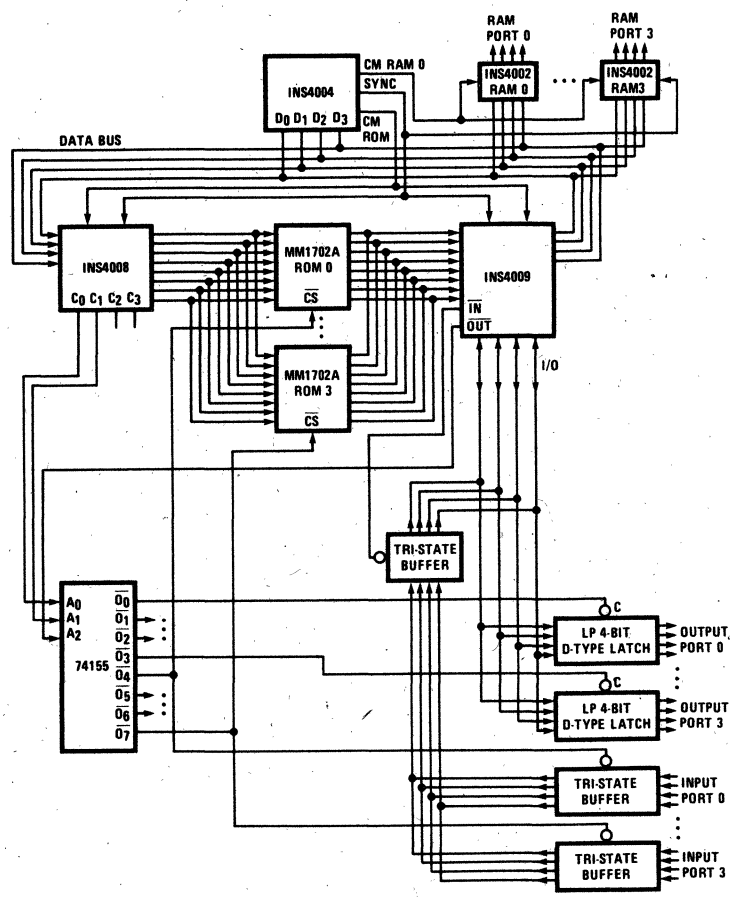
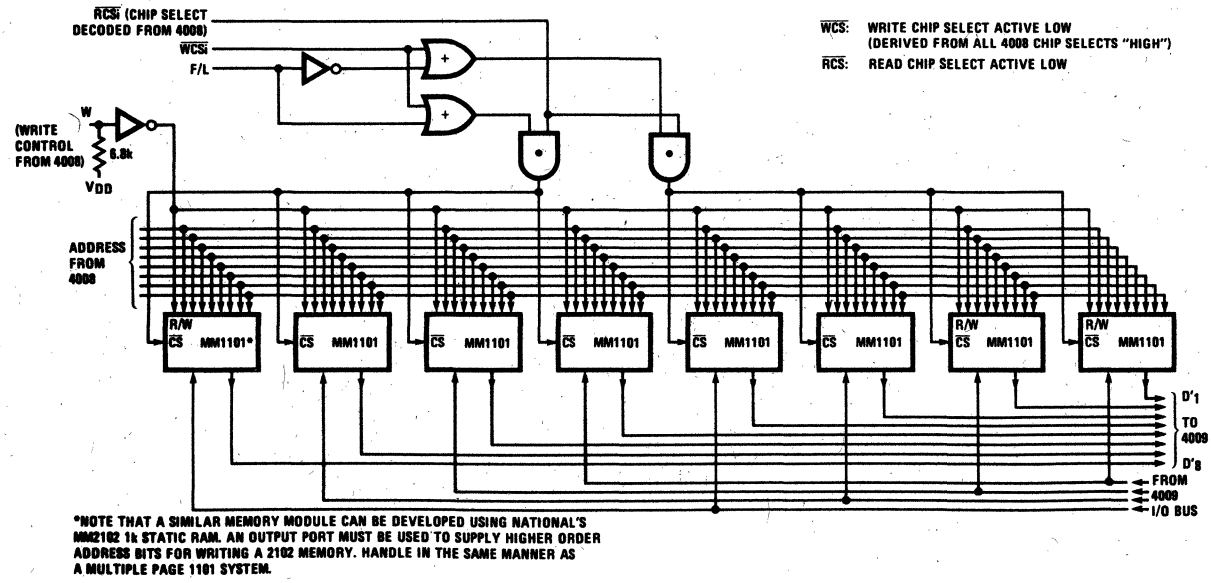


Example 1. Four MM 1702As and Four I/O Ports



Example 2. Read/Write Memory for Program Storage

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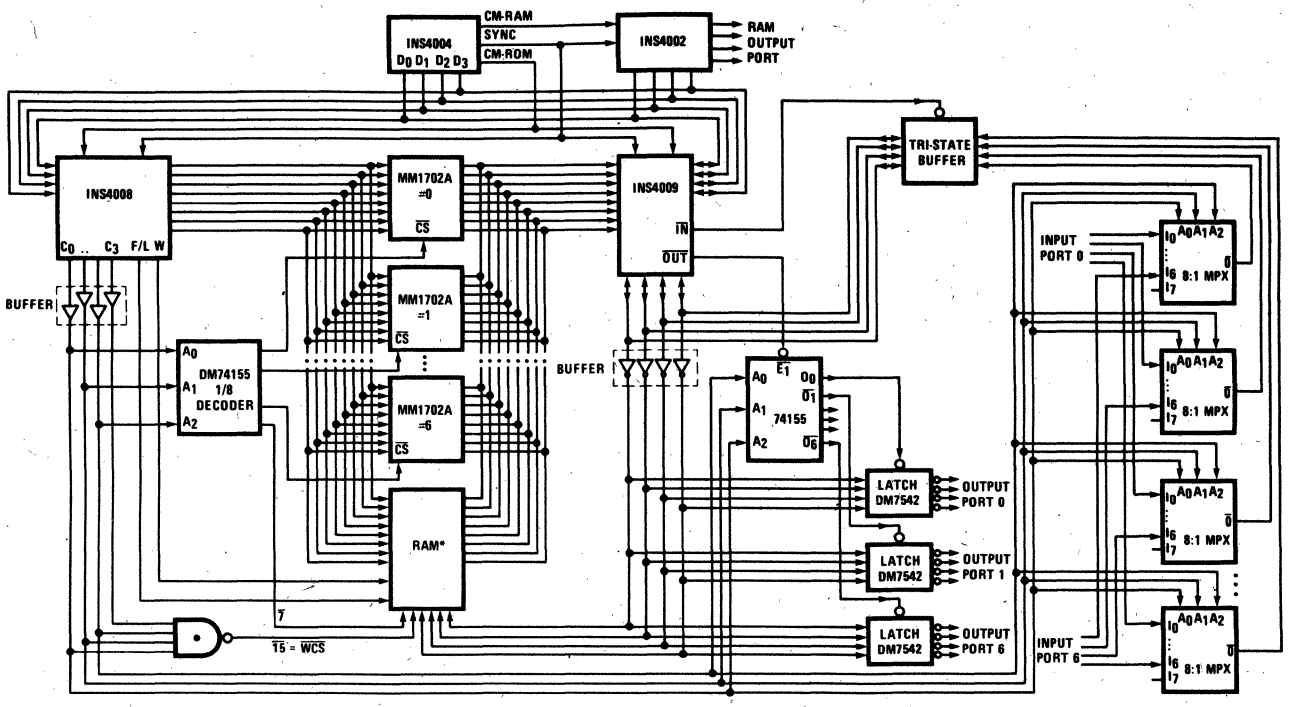
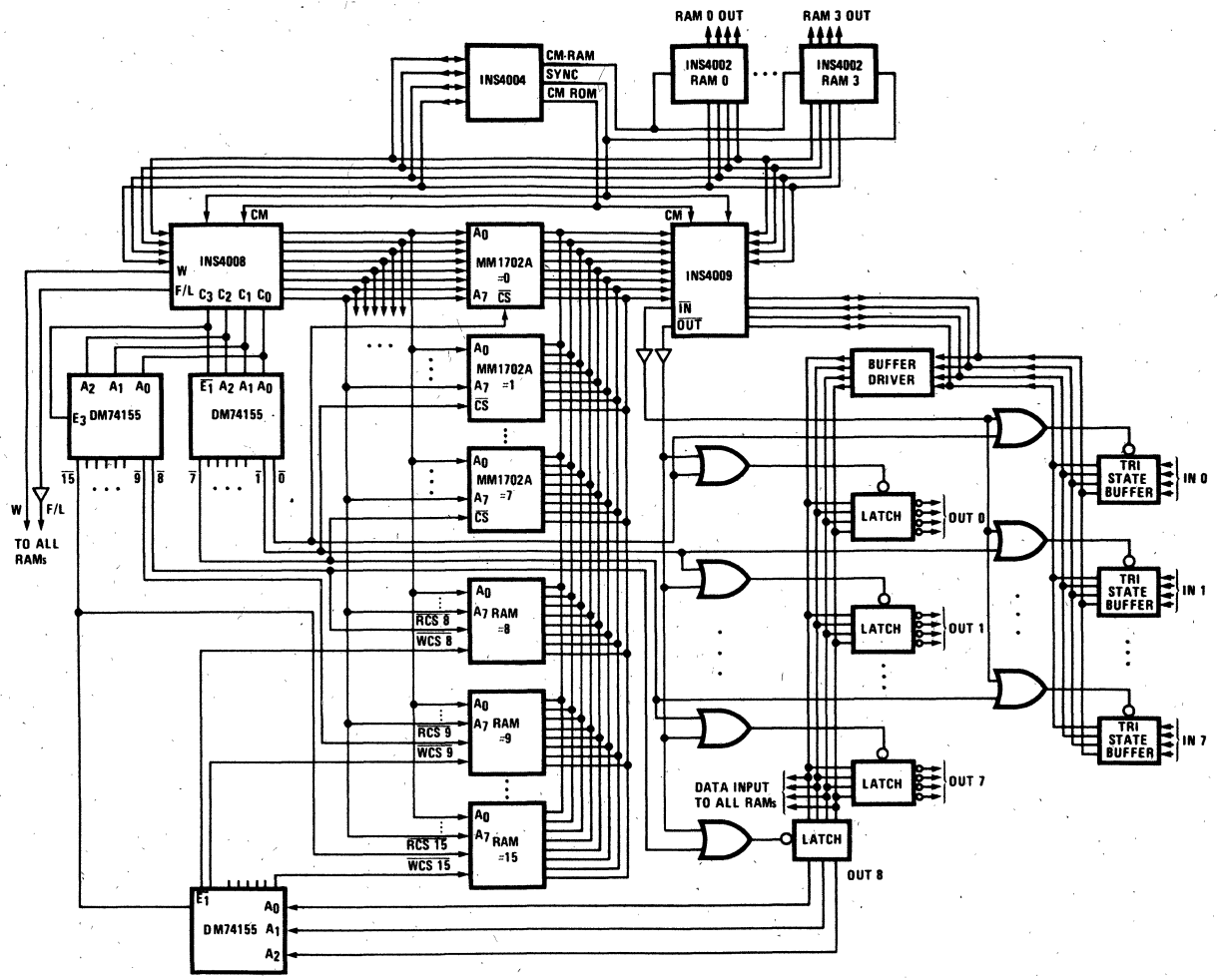


* A detailed RAM memory interconnection is shown in an accompanying figure.

Example 3. Program Memory with Seven Pages of PROM and One Page of RAM



Example 4. Program Memory with Eight Pages of PROM and Eight Pages of RAM

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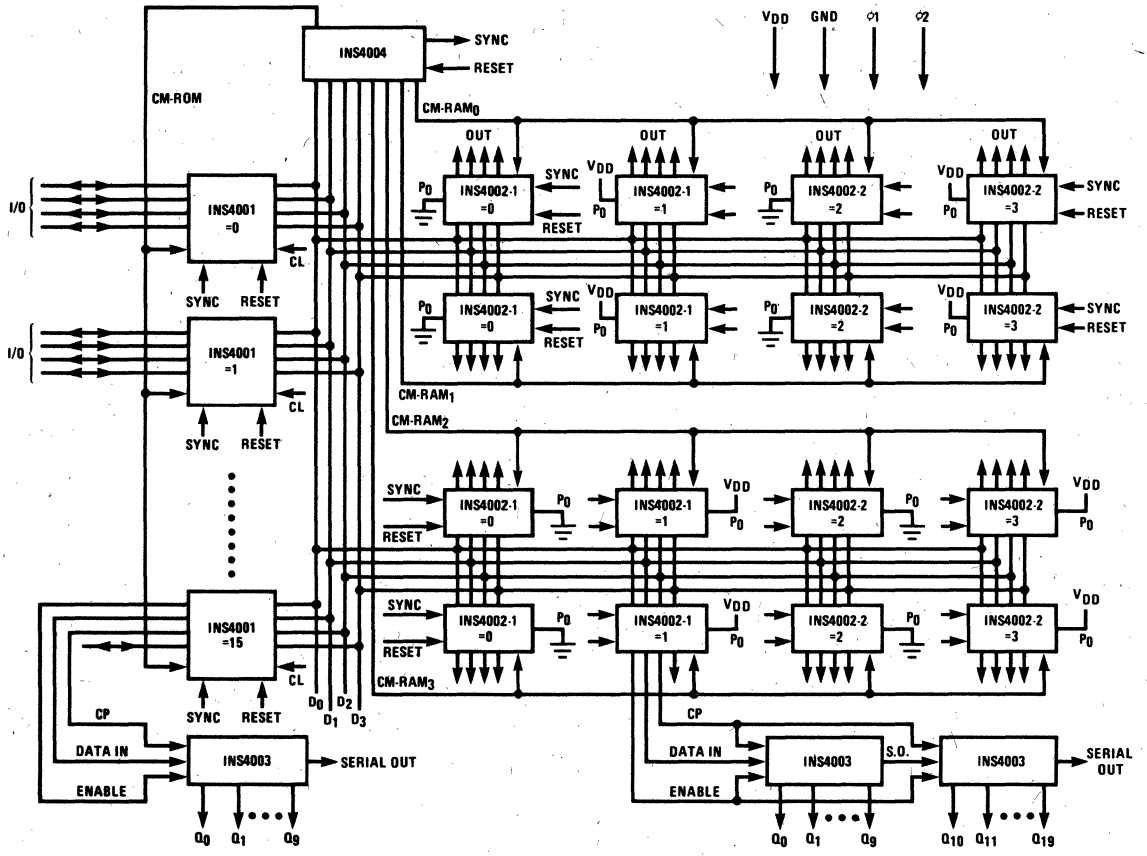
FIPS system interconnection



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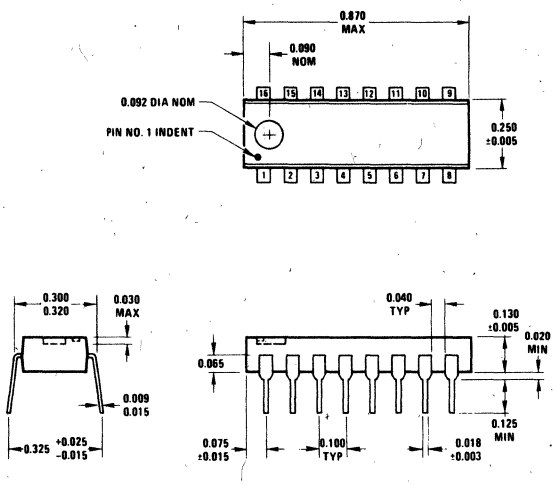
physical dimensions



Molded Dual-In-Line Package (N)

ordering information

NS PART NUMBER	EQUIVALENT INTEL™ PART	FUNCTION
INS4001	4001	256 x 8 ROM & 4-Bit I/O Port
INS4002-1	4002-1	320-Bit RAM & 4-Bit Output Port
INS4002-2	4002-2	
INS4003	4003	Shift Register
INS4004	4004	CPU
INS4008	4008	Standard Memory
INS4009	4009	I/O Interface Set

Manufactured under one or more of the following U.S. patents: 3083262, 3189758, 3231797, 3303356, 3317671, 3323071, 3381071, 3408542, 3421025, 3426423, 3440498, 3518750, 3519897, 3557431, 3560765, 3566218, 3571630, 3575609, 3579059, 3593069, 3597640, 3607469, 3617859, 3631312, 3633052, 3638131, 3648071, 3651565, 3693248.

National Semiconductor Corporation
2900 Semiconductor Drive, Santa Clara, California 95051, (408) 732-5000/TWX (910) 339-9240
National Semiconductor GmbH
808 Fuerstenfeldbruck, Industriestrasse 10, West Germany, Tele. (08141) 1371/Telex 27649
National Semiconductor (UK) Ltd.
Larkfield Industrial Estate, Greenock, Scotland, Tele. (0475) 33251/Telex 778-632

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MICROPROCESSOR CARDS AND MICROCOMPUTERS

—The logical total solution approach to fast, easy system design. National Semiconductor Corporation's microprocessor card and microcomputer families make it easy to design microprocessor-oriented equipment. Starting with **IMP,** then introducing **PACE** and **SC/MP,** National is continuously developing compatible microprocessor card systems fully supported with software, firmware, and services. Both the pre-engineered and tested card systems and the fully assembled microcomputers, give true computer performance in applications previously excluded by cost or development constraints.

- **Fast development time**
- **Reduced design/ documentation costs**
- **Low end-system cost**
- **Simplified system design**
- **Standard sub-assemblies**
- **Thorough testing before delivery**
- **Total solution approach support packages**
- **Fully developed software**
- **Single-source purchasing**
- **Supported by National Semiconductor Corporation**

Higher Profits From Faster Development

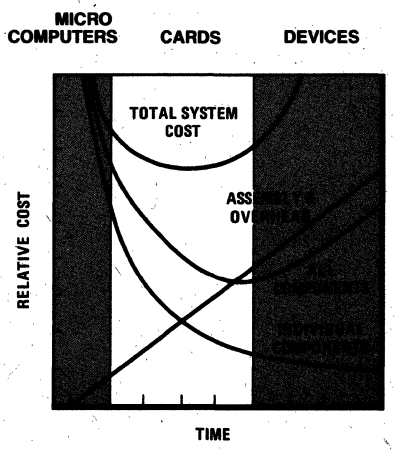
National microcomputers provide a step function decrease in the product development cycle length and cost. Since National's microcomputers are fully assembled and tested as a system, your engineering effort can be focused on program development and interface circuit construction unique to the application.

There are fewer printed-circuit boards to design, less hardware to stock and document, test system needs are greatly reduced. And, fully debugged operating and I/O software routines eliminate time-consuming program development at machine language level.

Your product comes to market faster, which means a larger share of the available market and higher profits.

National's microcomputers find beneficial application in low to medium volume production systems where engineering development, prototype fabrication and production costs must be minimized because of manufacturing volume.

National microprocessor card assemblies also provide many economic benefits in high volume applications. Unique systems can be configured using standard cards in combination with custom cards. Your engineering resources applied to the specialized part of the design will save you money.



Microprocessor-oriented systems get to market sooner than conventional systems and experience greater profits throughout product life.

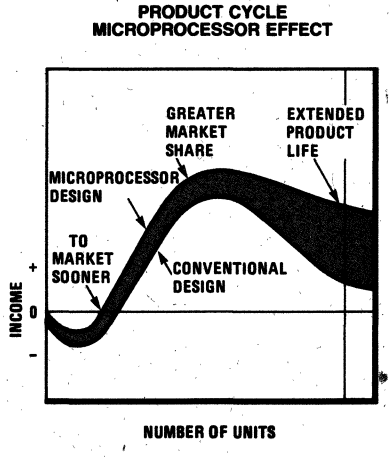
Economies Continue Through Production

The economies of using National's total hardware and prototype system products during new product development is carried through production. The purchase of a fully assembled and tested microcomputer card or system relieves you of the responsibility and expense of costly test equipment and inventory of individual components. National also offers a single vendor source for ancillary circuit modules and components commonly used in complete systems, such as LED displays, linear signal conditioning modules, A/D and D/A convertors, sensors and drivers.

Each National microprocessor card and microcomputer undergoes extensive outgoing inspection and testing which relieves the user of these expenses. Every unit receives burn-in and full functional testing under controlled temperature and environmental conditions. Since National has a substantial investment in production testing equipment, you frequently receive a more thoroughly tested product than you could produce yourself.

Substantial documentation further reduces overall costs. National Semiconductor Corporation has developed comprehensive user manuals, technical descriptions, and application notes which assist users in support of their systems.

Overall, the use of National microprocessor cards and microcomputers adds profits to all volume levels of microprocessor-based systems.



Proper selection of microcomputers, microprocessor cards or microprocessor devices is dictated by total system cost analysis.

MICROPROCESSOR

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National's Full Spectrum of Microprocessor Cards

...A family of families to fulfill most applications. National microprocessor cards and microcomputers are not just a family of microprocessors—they are a *family of families* designed to fulfill the application spectrum from low-cost to high performance and flexibility.

The economical SC/MP gives great design flexibility in low cost, 8-bit microprocessor systems. The single-chip, 16-bit PACE exhibits capabilities inherent in more expensive minicomputers. Finally, the IMP-16 provides the most sophisticated 16-bit bit-slice microprocessor system available today. The IMP-16 add-on instruction sets and choice of bussing architecture give designers complete versatility in developing highly specialized systems.

Each device family includes a family of I/O cards, peripheral controllers, and operating software or firmware. And, all families are supported by extensive programming software from **National Semiconductor.**

SC/MP

Features:

- Eight-bit instruction and data words conserve memory in simple applications.
- Four 16-bit pointer registers for easy address manipulation.
- Multiple addressing modes simplify programming.
- Common memory and peripheral addressing reduce bussing requirements.
- Built-in bus request logic for DMA and multiprocessor applications.
- Three flags allow direct bit-level interfacing.
- Two sense inputs test bit conditions.
- Separate serial ports provide easy direct I/O capability.
- Software controlled interrupts give versatile peripheral control.
- CPU with on-card read/write memory and PROM/ROM allows stand-alone single-card operation.

Applications:

- Appliances
- Simple games
- Educational systems
- Small machine control
- Automotive
- Intelligent I/O systems
- Add-on intelligent terminals

PACE

Features:

- 16-bit, single word instructions give low programming cost.
- 16-bit or 8-bit data word optimizes application suitability.
- Common memory and peripheral addressing allows use of memory reference instructions for peripheral control.
- Four general-purpose registers and ten-word, last-in-first-out (LIFO) stack reduce memory data transfers.
- Programmer accessible status register allows contents to be preserved, tested or modified directly.
- Five vectored priority interrupts eliminate external hardware circuits.
- Four flags and four jump conditions allow direct bit-level manipulation.
- Instruction set shared with IMP-16 for efficient programming.

Applications

- Test systems
- Instrumentation and data acquisition
- Machine tool control
- Business machines
- Word processing
- Terminal control
- Peripheral control
- Sophisticated games
- Communications

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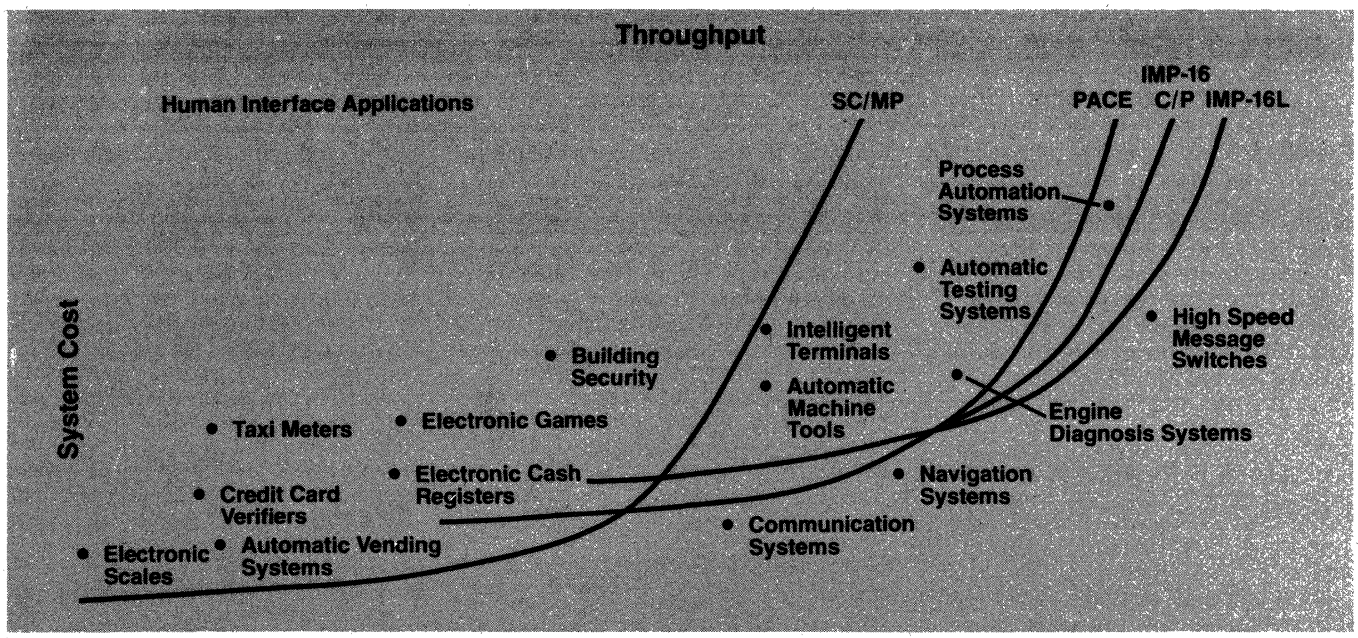

IMP-16C/P

Features:

- 16-bit, single word instructions.
- Expanded, Arithmetic and Power I/O instruction sets speed programming and thruput.
- Individual address, memory and peripheral busses simplify data handling.
- Expandable on-card read/write memory and PROM/ROM allow stand-alone application.
- 16-word LIFO stack and four general purpose registers reduce memory data transfers.
- Eight flag outputs and four jump inputs allow direct bit-level manipulation.
- Separate memory power and write inhibit lines safeguard memory data during power loss.

Applications:

- Process control
- Peripheral control
- Data Communication
- Point-of-sale systems
- Functional testing equipment
- Mathematical systems
- Navigation control

IMP-16L

Features:

- 16-bit, single-word instructions.
- Built-in DMA controller gives 16 megabit data transfer rate.
- Minicomputer-type architecture combined with read/write/PROM/ROM memory allows powerful two-card microcomputer system.
- Extended, Arithmetic, and Power I/O instruction sets give high performance data manipulation and mathematical capability.
- Register/accumulator configuration same as IMP-16C/P for programming ease.
- System architecture allows use of multiple CPU's for greater data handling capacity.
- Eight flags and four jumps allow direct bit-level manipulation.

Applications:

- Sophisticated instruments
- Business machines
- Store and forward networks
- Data communications
- Large data-base systems
- Data acquisition systems
- Remote job entry systems

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SC/MP

The SC/MP card system features a small, low-cost eight-bit microprocessor primarily intended for projects that demand cost-effectiveness, versatility, and ease of application. Especially useful when size or modularity is important, each SC/MP card measures only 4.375 in. by 4.862 in..

With a straightforward and powerful architecture, the SC/MP provides sockets for 512 bytes of ROM/PROM, 1 or 2K bytes of PROM/ROM, and 256 bytes of read/write memory along with clock and all the buffers necessary to be used as a stand-alone controller. For larger systems PROM/ROM and read/write memory cards allow expansion to 65K bytes (K=1024).

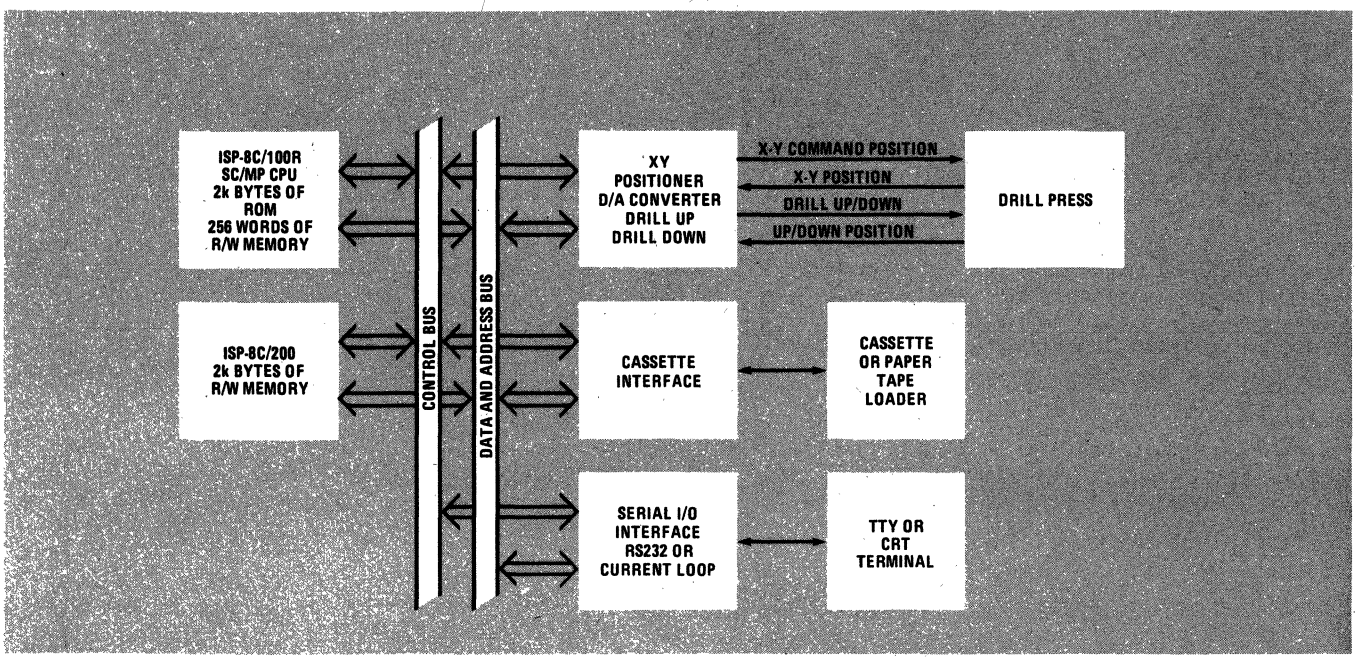
SC/MP cards transfer parallel data to and from user systems via a 16-bit TRI-STATE® address port and an 8-bit, bi-directional TRI-STATE data port. To reduce overhead, peripherals are addressed the same as memory. In addition, two ports are provided for serial data; one for input, one for output.

Forty-six general-purpose instructions simplify programming and aid in control flexibility. Easy configured real-time control is accomplished through two sense inputs and three user flag outputs. These signals are used for hardware control, software status or system control. The interrupt system is completely software controlled to simplify programming in event counting applications. Other hardwired control signals provide bus control, data-flow supervision and general SC/MP control.

Convenient Memory Addressing

Using the 16-bit address bus and the 8-bit data bus, the SC/MP has 16-bit address capability, allowing specific addressing of any one of 65,536 memory locations. PROM/ROM and read/write memory can be intermixed in this address space. Four pointer registers simplify subroutine calls and returns.

SC/MP has five addressing modes—program counter (PC), relative, immediate, indexed, auto indexed and implied. The PC relative mode gives fast access to memory data within +127 and −128 bytes of the address specified by the program counter. Immediate mode uses the second instruction byte as memory, avoiding unnecessary data addressing or fetching. Both indexed modes speed block transfers within the +127/−128 byte range referenced by the pointer register. The implied addressing mode uses the operation code to specify origin and destination addresses.



SC/MP AUTOMATED DRILL PRESS

Automated drill press illustrates versatility of SC/MP card system. Main control programs for general machine operation reside in ROM. Instructions regarding hole locations, drilling speeds, arbor travel rates and other project-specific information are loaded from cassette or paper tape into read/write memory card. SC/MP, using on-card read/write memory, controls complete operation. Operator loads tape, presses start-stop buttons, and responds to SC/MP directions on display.

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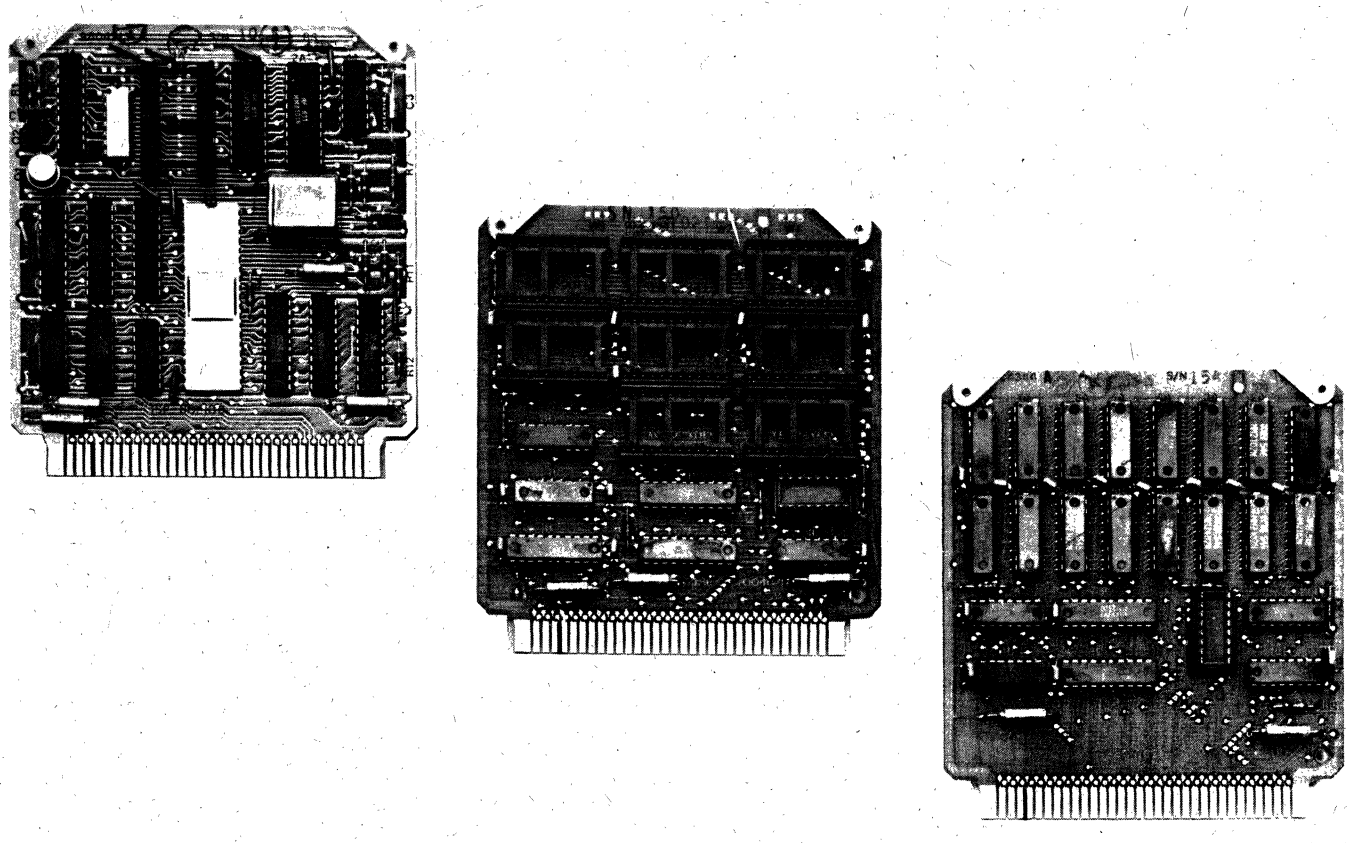
	Model Number Maximum Power Required	Size	Availability
CPU Card with on-card timing, buffered 16 bit address, and eight-bit data bus. Includes 256 bytes of read/write memory and sockets for 512 bytes PROM/ROM (uses MM5204Q/MM5214).	ISP-8C/100 +5V @ 600 mA −12V @ 150mA	4.862 in. by 4.375 in.	NOW
Card, same as above but PROM/ROM sockets replaced by hole pattern for 1k or 2k bytes ROM.	ISP-8C/100R +5V @ 600mA −12V @ 150mA	4.862 in. by 4.375 in.	NOW
MEMORY 2k byte static read/write memory card with on-card address decode.	ISP-8C/002 +5V @ 1.45A	4.862 in. by 4.375 in.	NOW
4k byte ROM/PROM memory card with on-card address decode. "B" designates card with sockets for 8 MM5204Q/MM5214. "P" designates card with 8 blank MM5204Q.	ISP-8C/004B or P +5V @ 550mA −12V @ 320mA	4.862 in. by 4.375 in.	NOW
I/O Serial I/O interface card, with selectable baud rate, and RS 232 and TTL and TTY (20mA loop).UART allows simpler I/O routines to be used.		4.862 in. by 4.375 in.	MAR 1977



"SC/MP" 8-bit microprocessor system. CPU card at left; ROM instruction card at center; RAM card at right.

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PACE

Since the introduction of PACE, the first, 16-bit, single-chip microprocessor, National has extended its total solution approach to application requirements with PACE cards. PACE cards provide fast, powerful, high-speed 16-bit data processing capability for applications where 8-bit devices are inadequate, and avoid costly external circuits when eight-, twelve- and 16-bit I/O data are intermixed. The basic configuration consists of a CPU card, a read/write memory card and a PROM/ROM card, each of which measures only 4.862 inches by 4.375 inches.

The CPU card contains the PACE chip, clock, and buffers for data and control signals. The CPU communicates to both peripherals and memory through a fully multiplexed system data bus. The read/write memory card provides 1024 16-bit words of static memory; the PROM/ROM cards have logic and sockets for up to 1024 or 2048 16-bit words of PROM or ROM. Memory cards contain all of the functions required to interface directly to the PACE CPU card, without additional engineering. Like all National card systems, memory is expandable to 64k words.

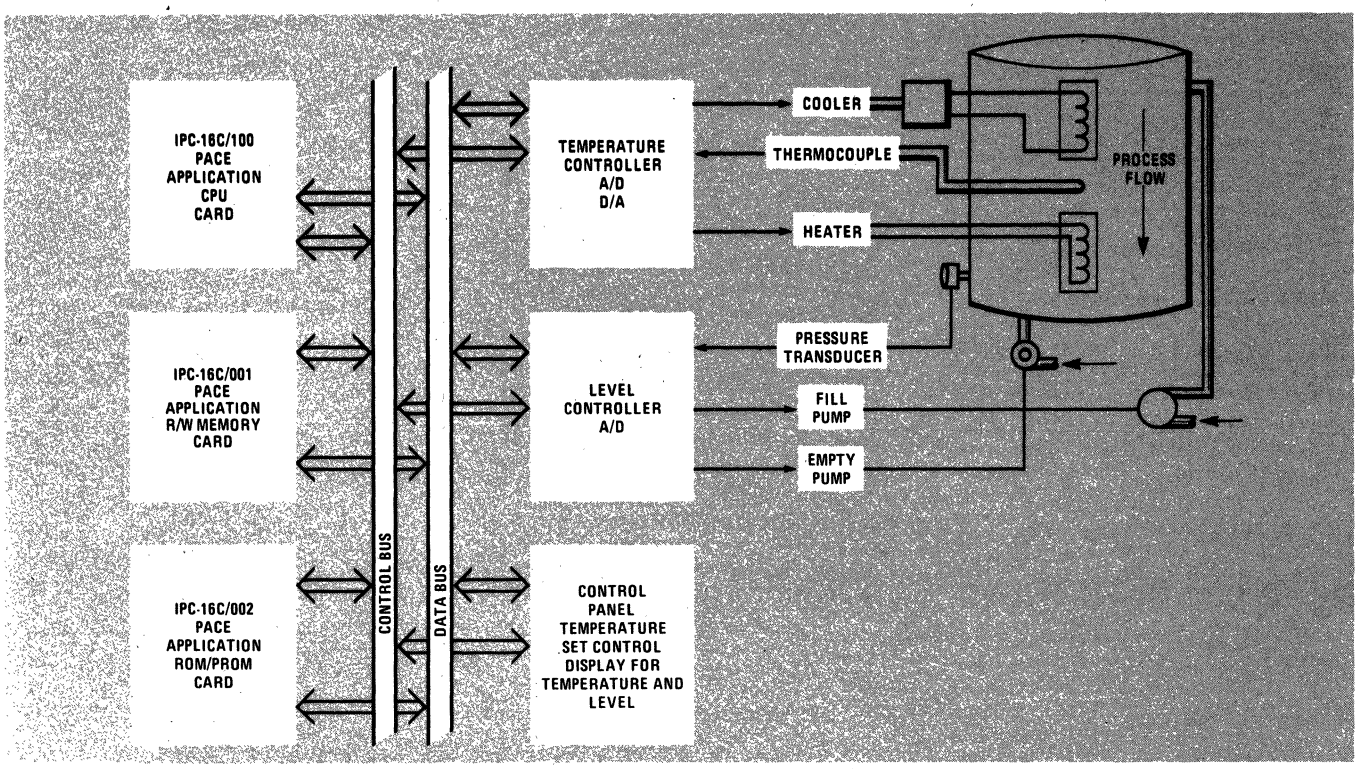
The small size, single function PACE cards permit use in physically confined spaces, and also provide the most cost-effective processor/memory configuration for each application.

For prototyping, National also offers a microcomputer system with complete control panel and additional PACE cards which contain hardware and application firmware necessary to interface with data processing peripherals. Support peripherals include an ASR33 TTY, a Documation M300 card reader, a 1000 CPS Paper Tape Reader, a 60-line-per-minute impact printer, and soon, a floppy disk. All peripherals are completely supported by software.

Flexibility Personified

The PACE card system and architecture is designed to satisfy a wide range of applications without additional external hardware. The flexible 45, 16-bit word instruction set allows convenient processing of either 8 or 16-bit data. Four user flags, four jump condition inputs and a five-level vectored priority interrupt system allow real-time control of virtually any system. Serial I/O data can be transferred via flags and jumps.

In addition, the PACE system was developed specifically for flexible programming. Four accumulators and a 10-word last-in-first-out (LIFO) stack eliminate time-consuming and memory-wasting external read/write storage in many applications.



PACE PROCESS CONTROLLER

PACE Process Controller uses CPU, read/write memory and PROM/ROM cards for level and temperature operation. PROM/ROM card contains operational programs as well as transducer, pump, heater, cooler, linearization tables and general process variables. Specific set points are entered into read/write memory from the operator's console. The IMP-16 applies signals with appropriate rate and proportional control.

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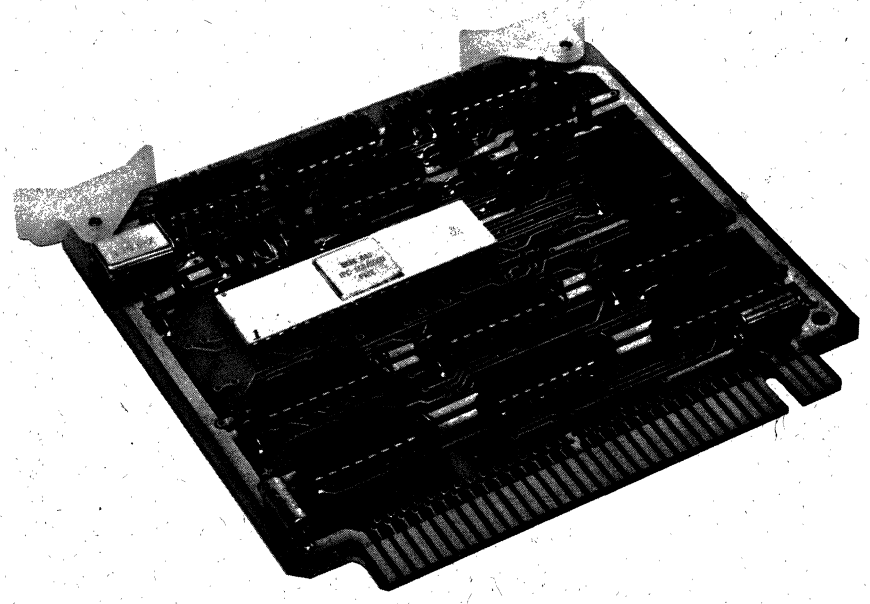
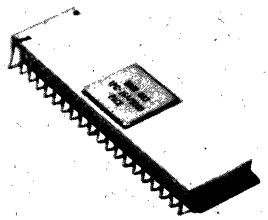
	Model Number Maximum Power Required	Size	Availability
CPU Card includes buffered data/address bus, control signals & timing circuits.	IPC-16C/100 +5V @ 725mA −12V @ 100mA	4.862 in. by 4.375 in.	NOW
MEMORY 1k by 16-bit static read/write memory card with on-card address decoding and separate memory power input and write strobe inhibit line.	IPC-16C/001 +5V @ 1.6A	4.862 in. by 4.375 in.	NOW
1k by 16-bit PROM/ROM card. "B" designates card with sockets for 8 MM5203Q/MM5213. "P" designates card with 8 blank MM 5203Q PROMs.	IPC-16C/001B or P +5V @ 1A −12V @ 510mA	4.862 in. by 4.375 in.	NOW
2k by 16 PROM/ROM card. "B" designates card with sockets for 8 MM5204Q/MM5214 devices. "P" designates card with 8 blank MM5204Q PROMs.	IPC-16C/002B or P +5V @ 1A −12V @ 510mA	4.862 in. by 4.375 in.	NOW
I/O Serial I/O card. Parallel to serial, serial to parallel I/O port with programmable baud rate. Serial interface capability consists of either RS-232C or 20mA current loop.		4.862 in. by 4.375 in.	MAR 1977
Parallel I/O card. Parallel to parallel, 16-bit asynchronous I/O port with control/status register to facilitate complete hand-shaking I/O control.		4.862 in. by 4.375 in.	MAR 1977





PACE CPU CARD AND PACE microprocessor chip

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IMP-16C/P

The IMP-16C/P cards are the real powerhouses of National's microprocessor card lines, providing ultimate flexibility in programming and data handling. IMP-16 CPU cards are available with two sizes of on-card memory; 256 by 16-bit words of read/write memory and sockets for 512 words of ROM or PROM or 1024 by 16-bit words of read/write memory and sockets for 1024 16-bit words of ROM or PROM. In many applications, one or the other of the CPU cards provide sufficient memory. However, additional read/write memory and ROM/PROM cards allow memory expansion to 65K words for sophisticated systems. All cards are 8.5 inches by 11 inches.

For programming flexibility, IMP-16s have a powerful 43 word instruction set resident in a Control Read Only Memory (CROM). Additional instructions of CROMs are added to enhance the basic set. The Extended CROM instruction set provides 17 additional instructions including single command multiply, divide, double precision add, double precision subtract as well as six memory reference instructions.

The ten-command Arithmetic Instruction Set speeds calculations involving high-accuracy fractional data and floating-point numbers. All data are in double precision numbers—32 bits is equivalent to 10 decimal places. Floating-point multiplication and division are ten times faster than with the basic and extended sets.

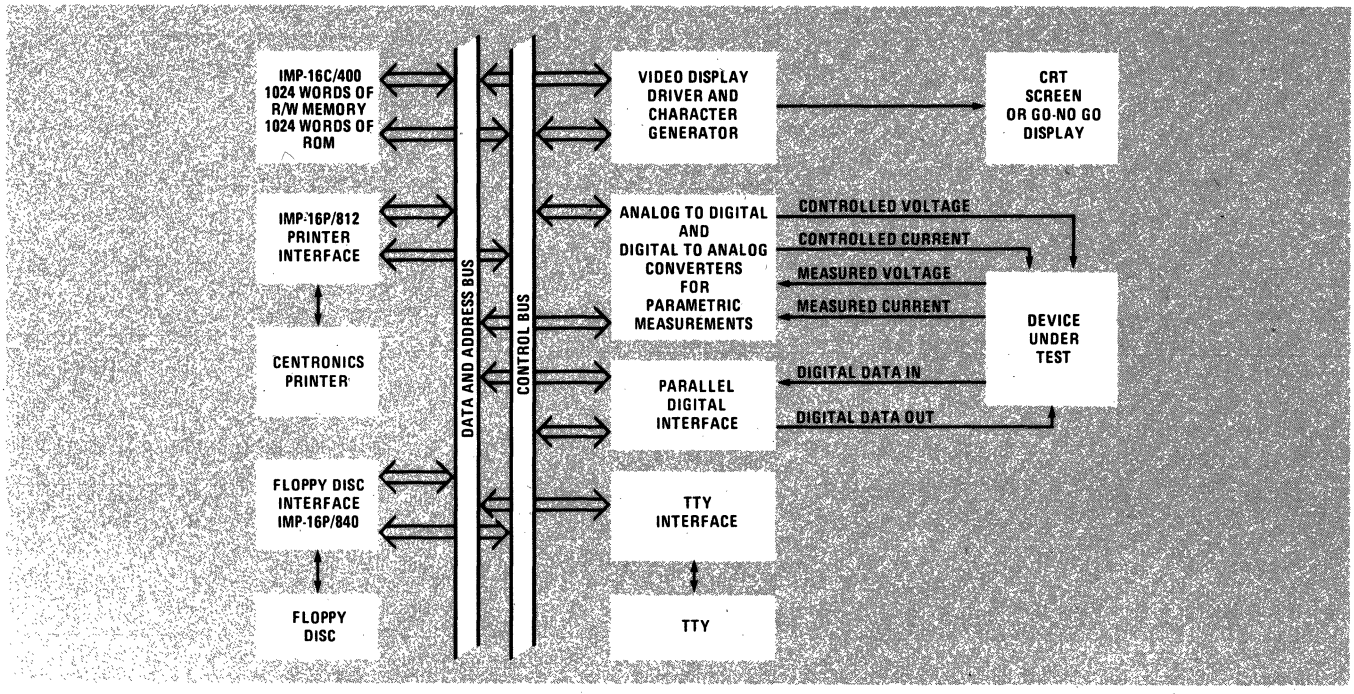
The nine-word POWER I/O CROM Instruction Set expands the IMP-16 repertory with special input/output commands that allow high-speed, block-data transfer between memory and peripherals. I/O speed is increased up to 87K words per second. In addition, the POWER I/O CROM reduces the time required to recognize peripheral interrupts.

Bussing for Fast Data Transfer

IMP-16s have individual 16-bit busses for address, peripheral data input, buffered data output and memory data input. This scheme allows peripherals to have the same address as memory locations, providing fast data transfer with a RIN or ROUT instruction.

For simplified serial communications with external devices, the IMP-16s have four general purpose jump condition inputs, six general purpose control flags, one general interrupt input and one vectored interrupt input.

IMP-16 cards are supported by a large number of peripheral interface cards. Included are an ASR33 TTY, a Documation M300 card reader, a 1000 CPS paper-tape reader, a 60 LPM impact printer, and a floppy disk. The peripheral cards include appropriate driver routines in firmware on the card.



IMP-16 ELECTRONIC DEVICE TESTER

IMP-16, with on-card ROM and read/write memory serves as sophisticated controller for electronic device tester. Various test routines are resident on the floppy disk and are transferred to the on-card memory for execution. No other memory is required. IMP-16 applies programmed static and dynamic stimuli, measures appropriate device reaction and applies necessary conversions. Output may be simple "go, no go" indication, complete characteristic display on CRT or printed, logged data.

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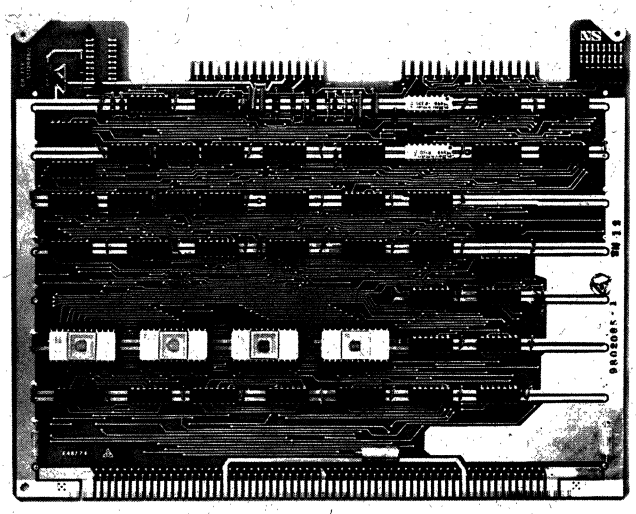
	Model Number Maximum Power Required	Size	Availability
CPUs A complete 16-bit microcomputer card with 256 words of read/write memory, sockets for 512 words of PROM/ROM (uses MM5203Q/MM5213), 2 interrupts, socket for additional CROM, (Extended, POWER I/O or Arithmetic) and memory addressability to 65k words.	IMP-16C/200A +5V @ 2.2A −12V @ 0.5A	8.5 in. by 11 in.	NOW
Microcomputer card with 1k words of read/write memory and 4 sockets for 1K words PROM/ROM (uses MM5204Q/MM5214). Card includes separate memory power input, write strobe, variable clock hold capability and extra socket for additional CROM (Extended, POWER I/O or Arithmetic).	IMP-16C/400 +5V @ 2.2A −12V @ 0.5A	8.5 in. by 11 in.	NOW
MEMORY 4k by 16-bit static read-write memory card with strobe inhibit line.	IMP-16P/004A +5V @ 2.4A −12V @ 0.5A	8.5 in. by 11 in.	NOW
8k by 16-bit PROM/ROM card for use with IMP-16C/200 or 400 with on-card address decoding. "B" designates card with 32 MM5204Q/MM5214 sockets. "P" designates card with 32 blank MM5204Qs.	IMP-16P/008B or P +5V @ 2.0A −12V @ 1.3A	8.5 in. by 11 in.	NOW
I/O TTY/Card Reader/Paper Tape Reader Card supplies two ports: one for TTY, the other may be used for the Documation 300 Card Reader or Plessey 1000 cps Paper Tape Reader. Driver routines are resident in ROM on board.	IMP-16P/810W +5V @ 1.5A −12V @ 0.1A	8.5 in. by 11 in.	NOW
Printer Interface Card for Centronics 306 printer includes cable, software and listings.	IMP-16P/812W +5V @ 1.0A	8.5 in. by 11 in.	NOW
Floppy Disk Controller/CRT Interface card interfaces National's Dual Drive Floppy Disk and any RS232 CRT to IMP-16C/200 or 400. Uses Shugart Disk Drives with storage capacity of 158K by 16-bit words per diskette. NOTE: Use requires modification of IMP-16P/810W for CRT.	IMP-16P/840W +5V @ 1.5A −12V @ 0.2A	8.5 in. by 11 in.	NOW



Teletype/Card Reader/Paper Tape Reader Interface.

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IMP-16L

The IMP-16L provides the ultimate in system performance and flexibility. It has the same architecture and configuration as the IMP-16C/P; however, on the IMP-16L a powerful DMA controller replaces the on-card memory. With a complete line of interface cards, the IMP-16L system can serve as a remote job entry system and perform other tasks traditionally in the minicomputer domain.

The IMP-16L has both the powerful IMP-16 43 word instruction set and the Extended CROM instruction set as standard features. It also accommodates either Arithmetic or POWER I/O instruction set CROMs. Combining the DMA capability with a special instruction set gives the IMP-16L the capacity for application in even the most difficult data handling systems.

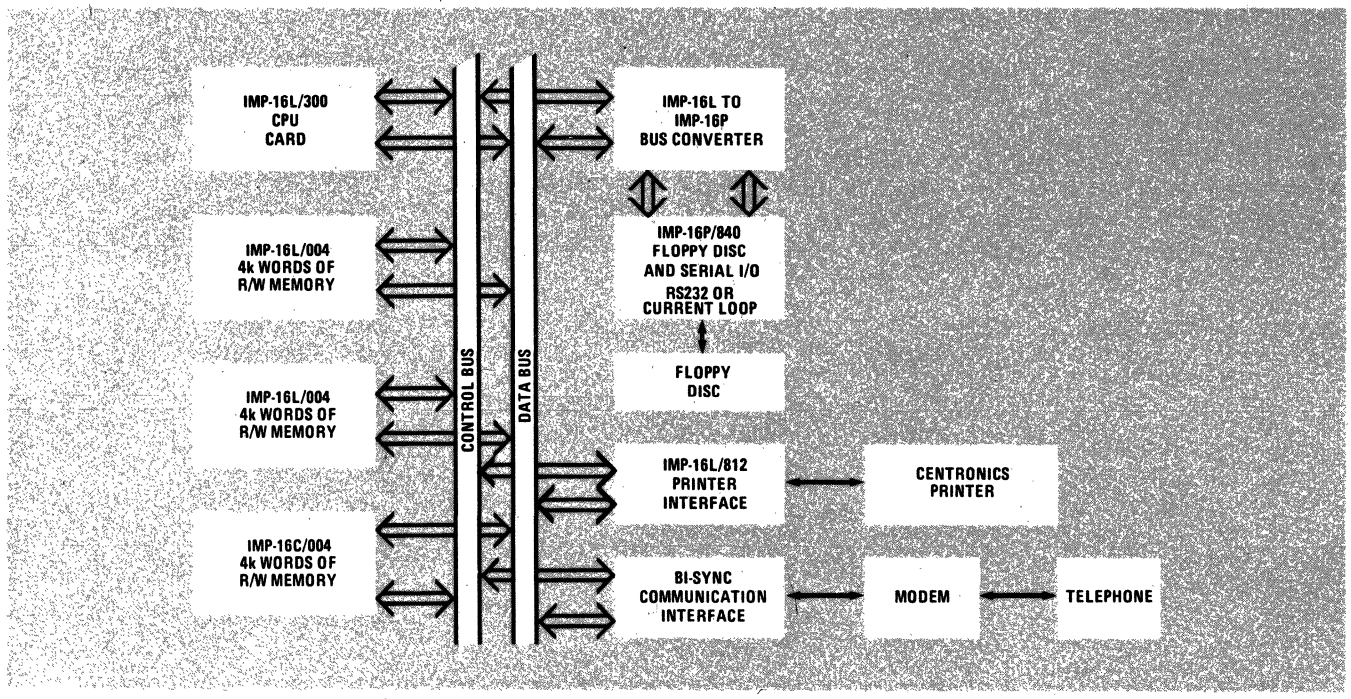
Transfer Data at 16 Megabits/Second

A high-speed asynchronous bus allows direct memory access by the peripherals at a 16 megabit per second transfer rate. Since programmed and DMA data transfers take place independent of CPU operation, up to three CPU cards may be placed on the bus to give greater processing capability.

Memory requirements are served by cards combining both read/write memory and ROM/PROM with compatible DMA ports. Depending upon the application, the designer may use only one CPU and one memory and to provide a basic two-card system that is more powerful than most mini's. For complex operations, memory can be expanded to 65k words in 2k or 4k increments, to provide most cost effective combination of PROM/ROM and read/write memory.

The IMP-16L has five user available flags, two jump conditions, four general purpose interrupts and one vectored interrupt.

Application programming is speeded with National IMP-16L software support—the IMP-16 editor, resident assembler, absolute and linking loaders, debug, diagnostics and IMP/FORTRAN cross assemblers.



IMP-16L MESSAGE COMMUNICATIONS NETWORK

IMP-16L CPU card with POWER I/O CROM instruction set and DMA capability controls message communications network. Operating systems, resident in floppy disk, are stored in read/write memory card locations. Incoming messages from either CRT or modem are queued and stored either in read/write memory or on the floppy disk under DMA control. IMP-16L formats outgoing messages and establishes line protocol for transmission through bi-synchronous communication interface. Incoming messages are printed in standard formats under IMP-16L control.

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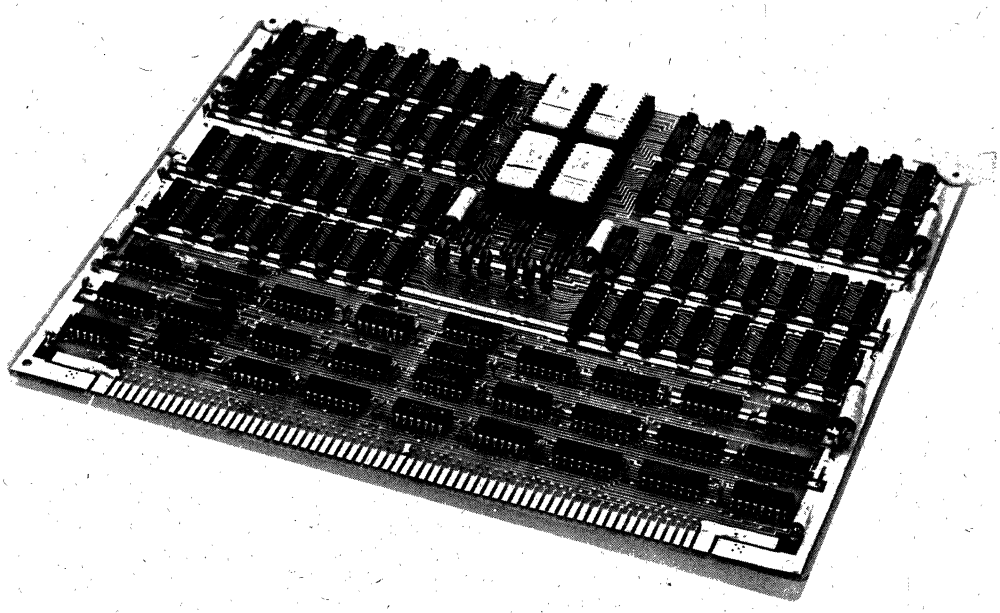
	Model Number Maximum Power Required	Size	Availability
CPU Card with DMA bus controller capable of data transfer of 16 megabits/second with Standard and Extended instruction sets. POWER I/O and Arithmetic may be substituted for Extended instruction set. Includes five interrupt and four bus control levels and bus controller expansion provisions.	IMP-16L/300 +5V @ 2.6A −12V @ 0.2A	8.5 in. by 11 in.	NOW
MEMORY 4k by 16-bit dynamic read/write memory card with compatible DMA port. Card has sockets for 4 MM5203Q/MM5213 PROM/ROM (512 words) with fixed address location (FEOO/FFFF).	IMP-16L/004 +5V @ 2.3A −12V @ 1.1A	8.5 in. by 11 in.	NOW
2k by 16-bit static read/write memory card with sockets for 4k by 16-bit PROM/ROM (Using MM5204Q/MM5214). Configuration may be used as the only memory in a system. Memory is expandable with any combination of memory cards. "B" designates card with 16 sockets for MM5204Q/MM5214. "P" designates card with 16 blank MM5204Q.	IMP-16L/006B or P +5V @ 4.5A −12V @ 0.4A	8.5 in. by 11 in.	NOW
I/O Printer interface card for Centronics 306 Printer includes interface cable and software.	IMP-16L/812W +5V @ 1.0A	8.5 in. by 11 in.	NOW
Card Reader Interface Card set includes 2 cards for interface to Documation 300, includes cable.	IMP-16L/825W +5V @ 2.5A	8.5 in. by 11 in.	NOW
Control Panel and TTY Interface cards. Provides interface to TTY and National's 16L Control Panel.		8.5 in. by 11 in.	NOW



Read/Write Memory Card

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DEVELOPMENT SYSTEMS AND MICROCOMPUTERS

...fulfill the total system approach.

National also supplies the total solution approach in the area of development systems and microcomputers. One end of the scale is the Low-Cost Development System for SC/MP, allowing cost-effective implementation of microprocessor cards in end-systems. At the other end of the scale, National supplies stand-alone microcomputers which serve both as operating hardware and as software development tools.

National's SC/MP and PACE Low-Cost Development Systems (LCDS) consist of hard-wired control and display circuits in an open-chassis configuration. There are five, bussed sockets for appropriate CPU, memory, I/O and customer designed interface cards; two cable sockets provide interconnections to expansion card cages.

The LCDS has a hex keyboard for manual data entry and control; an internal TTY interface expands manual entry and permits paper-tape I/O. The six digit display allows examination of register and memory contents. For easy operation, on-card ROMs contain the LCDS operational program, allowing immediate use without time-consuming program loading.

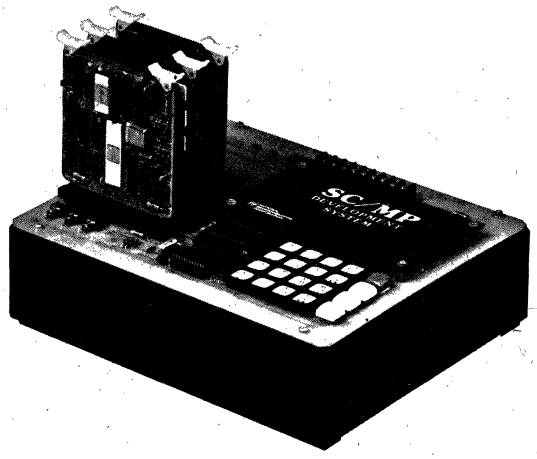
National's Low-Cost Development Systems speed microprocessor-system development. The designer builds application routines or subroutines directly by entering code through the keyboards. He may operate in a single-step or continuous mode with set break-points.

Alternatively, the designer uses the TTY to load paper tape in standard assembler format. In either instance, he has complete flexibility in developing his application programs. Using the LCDS, he may view, print and modify memory and register contents.

Once programs are debugged, the designer outputs the program or TTY tape, in a format compatible with National's PROM Programmers.

Using National's Low-Cost Development Systems, users can not only check-out hardware and interface design concepts but also build software packages and convert them to firmware as well.

National's PACE and IMP microcomputers provide all the benefits of the LCDS and more. They are fully assembled and tested units which expedite end-product delivery and function as design aids in program development.



Low-Cost Development System uses SC/MP cards as foundation for system design.

IMP-16L microcomputer with PROM Programmer Board allows quick conversion of software to firmware, and speeds developing interface circuits.

National microcomputers, used in conjunction with PACE or IMP-16 cards or devices assist development of systems, significantly reducing development time. Once a flow diagram has been established, the designer can immediately begin software and firmware development—even before hardware has been prototyped.

The PACE Development CPU Card is supplied with a cable that permits connection of the IPC-16P into an application system in place of a PACE Application CPU Card. Thus, the prototyping features inherent to the IPC-16P Control Panel, peripherals, and software can be used to develop a user application system containing PACE application cards.

The IMP microcomputers have extra, pre-wired slots for IMP cards and interface circuits. Prototype system interface cards, installed in the microcomputer, can be checked-out thoroughly prior to committing the cards to production.

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Software Development

To further aid the system designer, National has extended its total solution approach thru hardware into software development. To satisfy learning requirements of software development, National Semiconductor offers thorough software documentation, programming courses, TTL logic to software conversion guides and standard software libraries.

Preparation of operating system software requires instructions to be written, edited, converted to machine language (assembly) and debugged. The cost of these tasks is minimized if the microprocessor has a powerful instruction set; if aids such as editors, assemblers, debug routines loaders, and diagnostic routines are readily available and powerful; and if needed, peripherals and support systems are readily available.

National satisfies all of these requirements with products such as:

- Prototyping systems available with TTY, card reader, high speed paper tape, floppy disk, high speed printer and CRT peripherals.
- Systems with complete program panel for single stepping, register examination and loading.
- Software support programs such as linking loaders, relocating assemblers, powerful editors and conversational assemblers are available in 3 forms—resident that run in prototyping systems, installed on time share facilities world wide or in ANSI Fortran IV for installation in your 16 or 32 bit in-house computer.
- Debug packages with features specifically designed for microprocessor programming.
- Regional training centers and thorough documentation, with formats designed for both skilled and first-time microprocessor programmers.

FULL SUPPORT CAPABILITY

Hardware

National makes it easy by providing all the pieces from components to packaging hardware. All of the ancilliary devices required for a complete microprocessor-based system are supplied by National *and* have been proven in systems produced by National.

- Memories
- Clocks
- Keyboard Encoders
- Multiplexors
- A/D & D/A Converters
- Logic Elements
- Voltage Regulators
- Line Drivers and Receivers
- Displays and Drivers
- Transducers

National also supports microprocessor card and microcomputer systems with a full line of packaging hardware.

- Card Cages
- Blank Prototyping Circuit Boards
- Card Connector Panels
- Extender Cards
- Sockets & Connectors

Engineering Support

To aid user engineering staffs, National provides a wide range of documentation assistance, including Application Notes, Technical Descriptions, Application Manuals, Utility Assembler and Timesharing Manuals; PROM Program Manuals, even a Logic Designers Guide to Programmed Equivalents of TTL Functions.

For in-depth training, National Provides engineering workshops at regional training centers throughout the United States. The curriculum, divided into four optional five-day sessions, progresses from microprocessor basics through advanced microprogramming.

Field Support

National's Area System specialists, knowledgeable in both hardware and software, provide valuable on-site assistance for user applications. Also, operating microprocessor systems are available in area offices for hands on demonstrations and software counselling.

Additional user and system specialist support is available thru Factory Application Engineers and other highly-specialized personnel. With many years of microprocessor experience, National's user support groups offer the user expert solutions to microprocessor design problems.

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Computer on a chip.

From TI's TMS 1000 Series. Versatile. Cost-effective. Fully-supported.

Now, you can use microcomputers in a wide variety of applications where previously they were prohibited by economic and design considerations. The age of the pervasive microcomputer is here in the form of TI's TMS 1000 series: an ALU, memory, and I/O all on a single chip!

Cost-Effective
Already in volume production, this field-proven, p-channel MOS series of one-chip microcomputers is extremely low in cost compared to other design approaches.

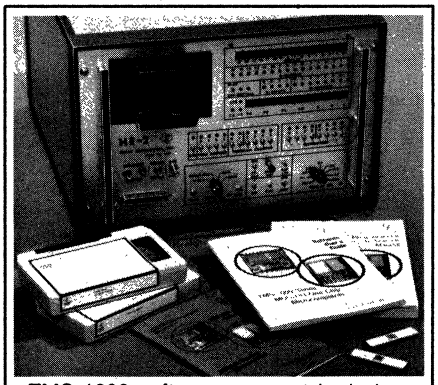
For example, the best alternate approaches are 4-bit microprocessor devices generally requiring five to seven individual packages to do what one TMS 1000 does. Considering expenses such as stocking, pc board costs, component costs, testing, and inventory, the cost for production runs using such kits exceeds the single-chip TMS 1000 approach several times over.

Assembly costs are substantially lowered by the significant reduction in package count; and a TMS 1000 single-chip approach greatly enhances system reliability.

Design Flexibility
To help you match microcomputer to specific application needs, the TMS 1000 series is family-engineered to provide flexibility for a wide range of applications. The TMS 1000/1200 are basic 1024-instruction ROM microcomputers, ideal for low to medium complexity applications.

The TMS 1070/1270 members of the family are identical to TMS 1000/1200 but allow direct interfacing to high-voltage indicators such as the popular neon type displays.

TMS 1100/1300 have twice the memory capacity of the 1000/1200 devices allowing expansion into added functional requirements thereby providing the flexibility for highly complex applications.



TMS 1000 software support includes: HE-2 hardware emulator. SE-1 and SE-2 system emulators. Program Reference Manual. Software User's Guide. And TMS 1000 Data Manual.

Software and Prototyping Support
The fully supported TMS 1000 family offers a variety of design aids to assist you with your specific application. For example, the SE-1 or SE-2 system evaluators are chips functionally identical to the TMS 1000/1200 and TMS 1100/1300. They can be combined with external instruction memory so you can check your instruction programming before shifting into volume production.

And the HE-2 hardware evaluator allows you to verify your program in real time. The HE-2 emulates all the TMS 1000 series devices and considerably shortens design time.

Worldwide timeshare software is available for simulator and assembler programs—ready for customer timeshare access at any time.

Software documentation provided by the Programmer's Reference Manual and Software User's Guide will easily guide you through the programming stages.

New Capacitive-Touch Interface
Complementing the TMS 1000 series is TI's new TMS 1976 Capacitive-Touch Interface Circuit. It converts outputs of a capacitive-touch keyboard into signals compatible to the TMS 1000 series for applications using touch-to-operate controls.

Full Customer Support
With such a vast range of applications, the TMS 1000 series will be used by some who are not totally familiar with electronic designs. TI's established network of field sales personnel backed by field-located microprocessor specialists will support your design efforts. TI also provides videotape instruction on a loan basis, as well as a full, inexpensive training course conducted in Houston. TI's applications staff is standing by to provide additional support. From the idea to the finished product TI will assist in design, training, and service.

For more information on the versatile, cost-effective TMS 1000 series microcomputers send for our Data Manual (CB 177-1). Write to Texas Instruments Incorporated, P.O. Box 5012, M/S 308, Dallas, Texas 75222. And if you are anxious to discuss a new TMS 1000 design call your local TI sales office.

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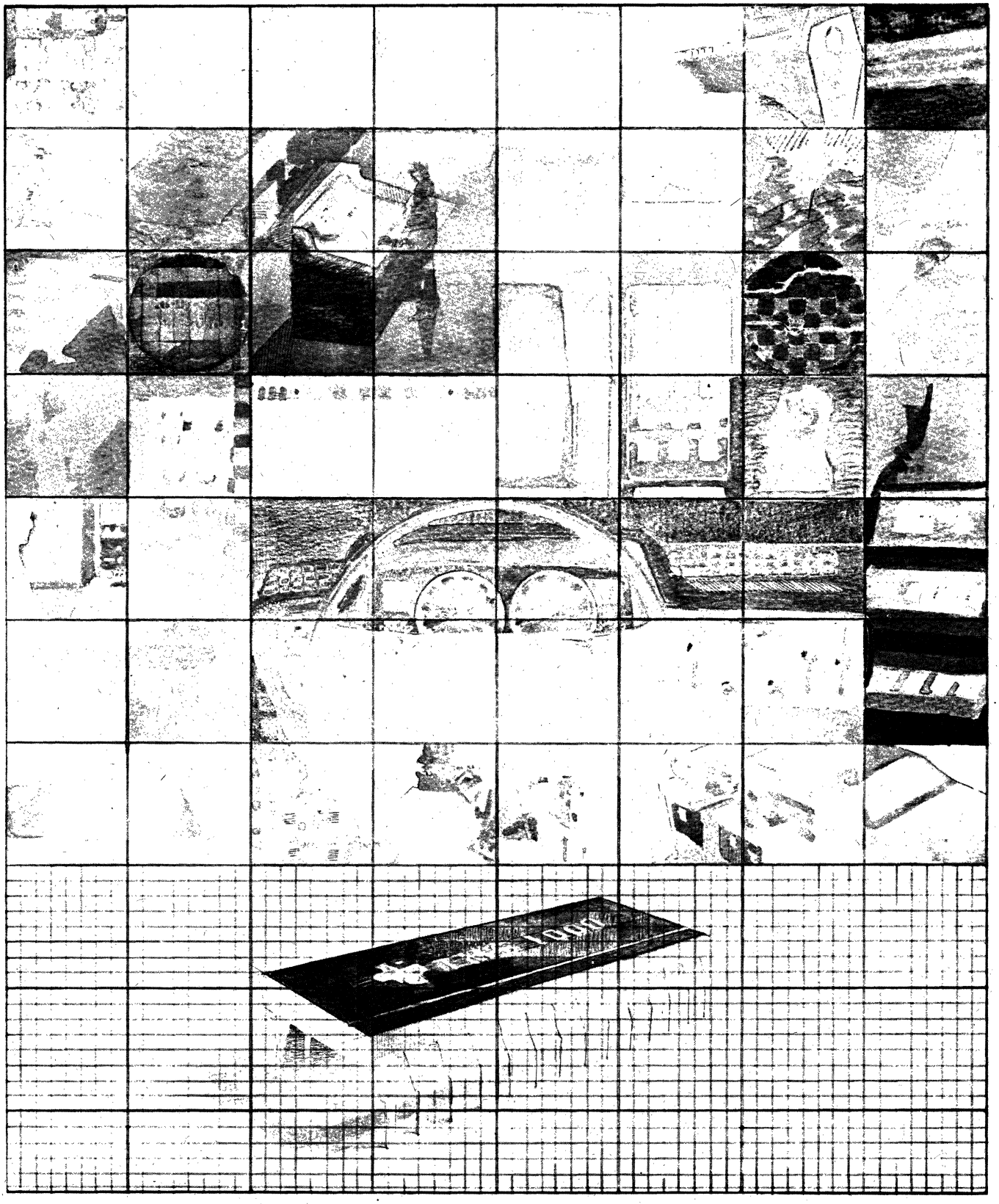

TI's TMS 1000 series is unique among microprocessors. Versatile. Flexible. Cost-effective. For applications requiring economy, small size, low power, and high reliability. Printer controllers. Remote sensing systems. Cash registers. Appliance controls. Automobiles. Vending machines. Electronic games. Industrial automation. Communication systems. Smart terminals. Peripheral equipment. Test instruments. Gas pumps. Credit card verifiers. Telephone controls. Multiple timers. Data terminals. Traffic light systems. And many more.

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Now, minicomputer performance from a 16-bit microprocessor: TI's new TMS9900. ...And it's only the beginning.

Unmatched. In word size. Instruction set. Addressing capabilities. TI's 16-bit TMS9900 microprocessor.

Powerful enough to be the heart of a minicomputer. Ideal for terminals. Instrumentation. Machine control. Scores of OEM applications. Destined to become today's and tomorrow's design standard.

Because the TMS9900 microprocessor represents more than just a single device. It introduces a new family concept allowing full design flexibility. Enabling you to move freely and easily over your entire range of applications. Now. And in the future. With less redesign. Less software reinvestment. Less relearning. Less obsolescence.

Improved System Cost/Performance
Compared to 8-bit μPs, TI's TMS9900 microprocessor provides these unmatched savings:

- 30% faster execution time
- 50% saving in program coding
- 50% saving on system interface costs
- 50% more efficient interrupt handling
- 20% reduction in memory bit requirements

These benefits stem from the TMS9900's advanced features:

16-bit instruction word with full 16-bit data precision.

Operation at 3.3 MHz clock rate.

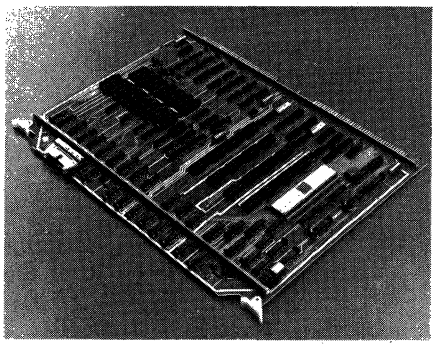
Full minicomputer instruction set including hardware multiply and divide.

Advanced memory-to-memory architecture that locates general-purpose register files in memory.

Separate address, data, I/O and interrupt buses.

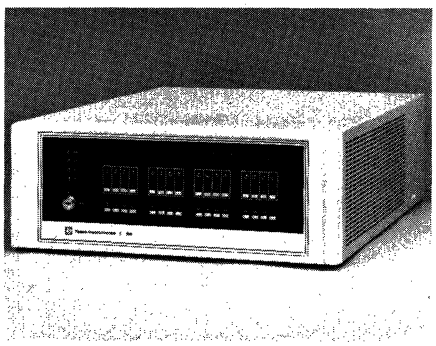
Complete Design Support
Hardware and software development tools are available to help you utilize the 9900. For evaluation and development work, there's the 990/4 board level microcomputer. In a desk-top chassis, the 990/4 serves as a fully supported prototyping system. And for larger software development, there's the 990/10 TTL minicomputer. All available now.

For design assistance, TI microprocessor applications specialists are located in 12 TI field sales offices.



990/4 Board System

Fully Compatible Software
The 9900/990 software has been tested and proven in more than 1000 systems. Any software you develop for the TMS9900 can be used with the 990/4 and 990/10 minicomputers – or the SBP9900 and TMS9980 microprocessors. In fact, any software developed for the TMS9900 can be used with any other family member – at present and in the future.



990/4 Prototyping System

More 9900 Family Soon
The TMS9900 is just the beginning. Future family circuits, all software compatible: SBP9900, an I^2L microprocessor designed to handle military temperature ranges. TMS9980, an N-channel μP with an 8-bit data bus for smaller systems.

Also coming are 9900 peripheral support circuits: TMS9901 programmable systems interface. TMS9902 asynchronous communication controller. TMS9903 synchronous communications controller. And the TIM9904 low power Schottky TTL 4-phase clock generator.

New Brochure Available
More detailed information on the TMS9900 16-bit microprocessor is contained in a new brochure, CB-235, just published by Texas Instruments. For your copy, and for additional data on the 9900 First Family, call your nearest TI distributor. Or write Texas Instruments Incorporated, P. O. Box 5012, M/S 308, Dallas, Texas 75222.

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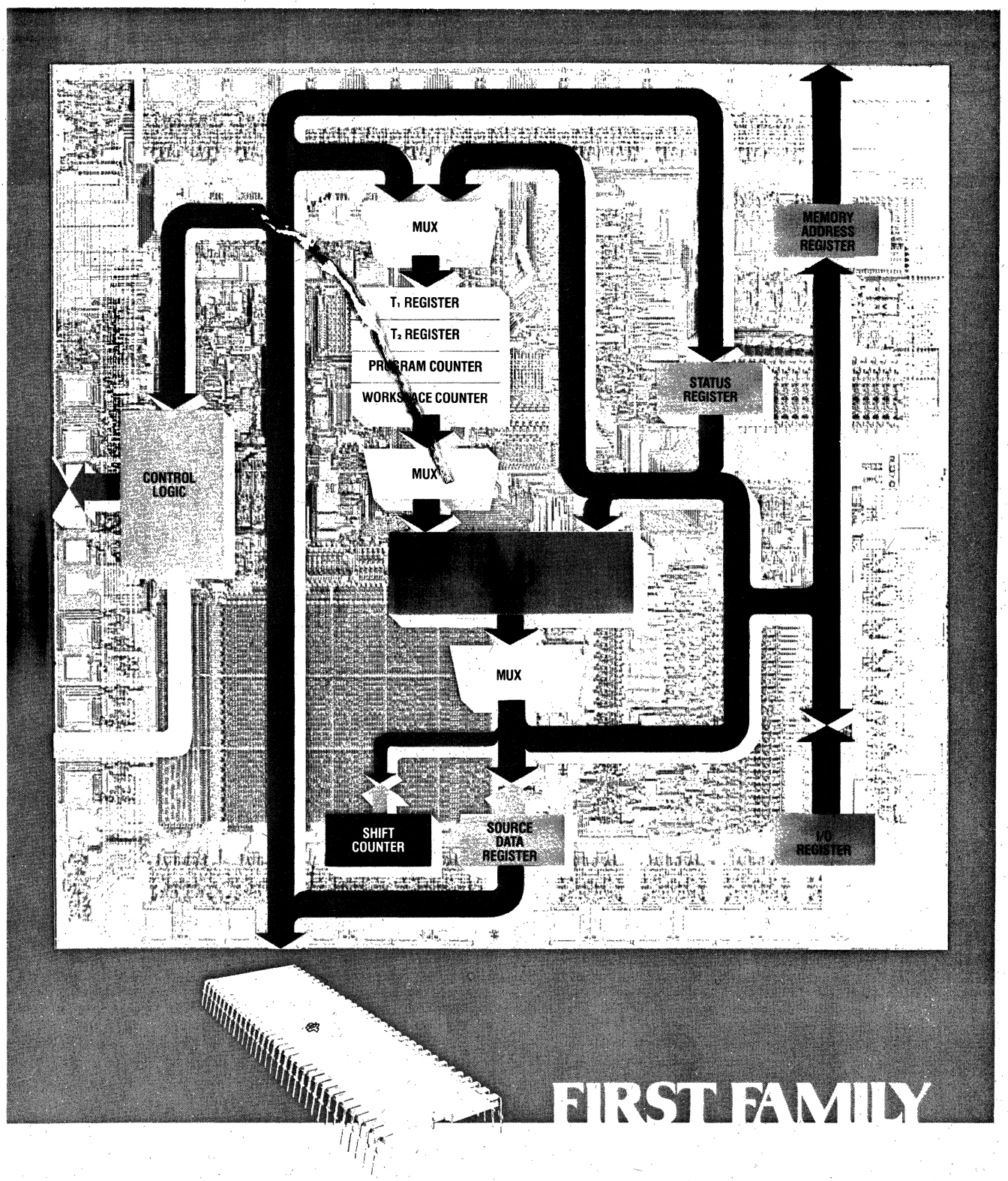

TI's new single-chip, 16-bit TMS9900 microprocessor is the frontrunner of a revolutionary new family. The first family of software-compatible microprocessors, support circuits, microcomputers and minicomputers. To give you unlimited design flexibility. A technological milestone achievable only by a leader in both integrated circuits and minicomputers.

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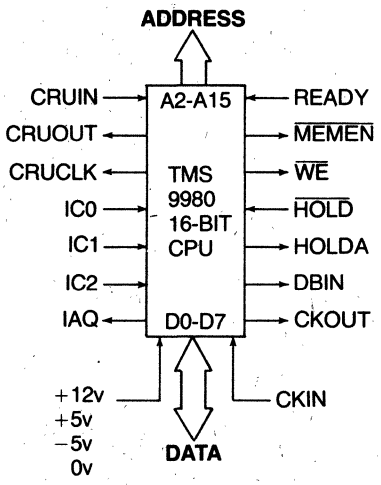
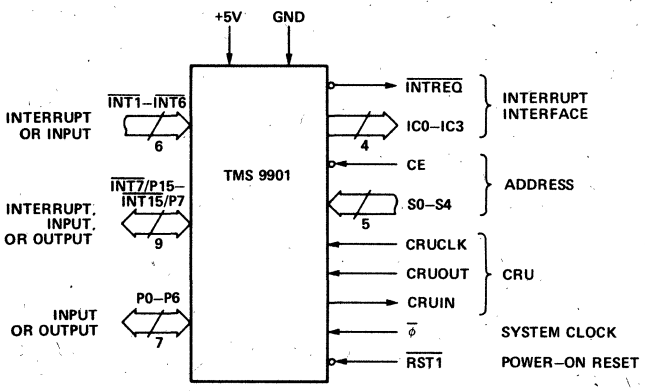
TMS9900 Microprocessor Family
TMS9980 Microprocessor



FEATURES

- Full TMS9900 instruction set
- On-chip oscillator and clock generator
- 8-bit data bus
- 16K byte memory address
- 2K CRU bit address
- 4 interrupts
- LOAD, RESET functions
- Direct memory access
- +12v, +5v, GND, −5v supplies
- N-channel silicon gate process
- 40 pin dual-in-line package

TMS9901
Programmable System Interface



FEATURES

- CRU peripheral for the TMS9900 and TMS9980
- 22 program selectable pins
  - —6 inputs/interrupts, 9 inputs/outputs/ interrupts, 7 input/outputs
- Interval timer
  - —clocked by TIM9904 ϕ3 output
  - —level 3 interrupt
  - —21 μs to 699 ms, parallel read
- Stackable for interrupt and I/O expansion
- Single 5V supply
- N-channel silicon gate process
- 40 pin dual-in-line packages
- Replaces 25 SSI and MSI packages

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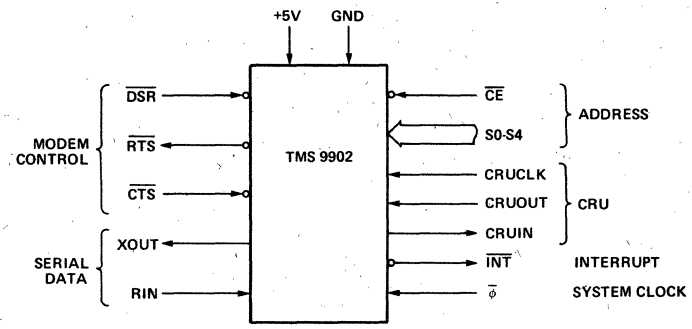
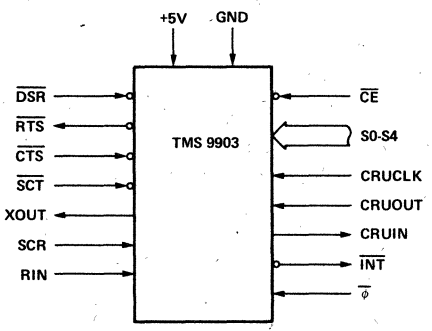
TMS9902
Asynchronous Communications Controller



FEATURES

- CRU peripheral for TMS9900 and TMS9980
- Provides interface to asynchronous modem or terminal
- Programmable data rate for any rate up to 250K BPS
- Programmable character length (5-8 bits), stop bits (1, 1½, 2), parity (odd, even, none)
- On-chip interval timer (64 μs to 16.32 ms)
- Socket compatible with TMS9903
- Single 5V supply
- N channel silicon gate process
- 18 pin dual-in-line package
- Replaces 45 SSI and MSI packages

TMS9903
Synchronous Communications Controller



FEATURES

- CRU peripheral for TMS9900 and TMS9980
- Provides interface to synchronous modem and other serial devices
- DC to 500K BPS data rate
- Allows interface to unclocked data with 32X clocks
- Line protocols include BI-SYNC, SDLC, HDLC, ADCCP, ATA/IATA
- Dynamic character length selection
- Two programmable sync registers
- Automatic zero insert and delete for SDLC, HDLC, ADDCP
- CRC generation and detection (programmable polynomial)
- On chip interval timer (64 μs to 16.32 ms)
- Socket compatible with TMS9902
- Single 5V supply, 20 pin dual-in-line package
- Replaces 100 SSI and MSI packages

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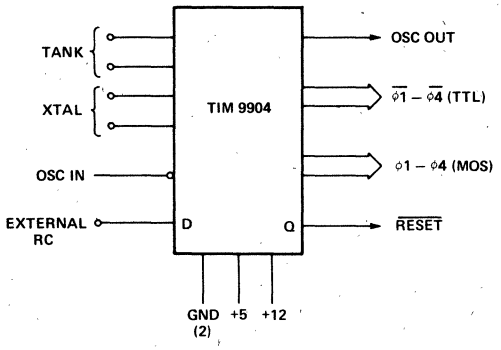
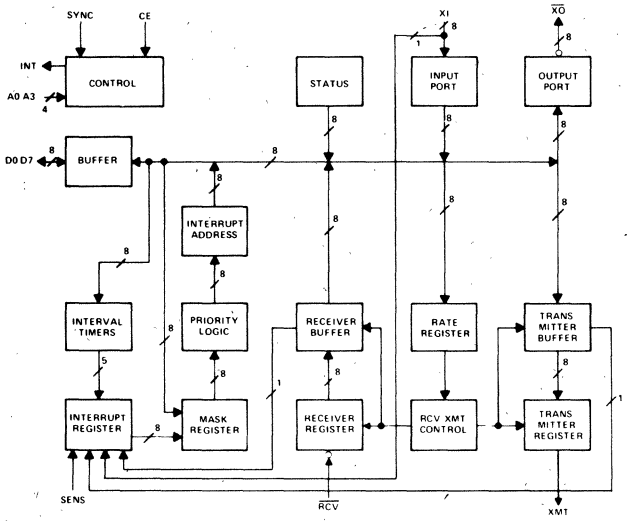
TIM9904 Clock Generator



FEATURES

- Single chip oscillator and clock driver for TMS9900
- Crystal controlled, LC controlled, or TTL input
- 3 MHz operating frequency
- Low power Schottky
- Shaping and synchronization of RESET signal
- 20 pin, 300 mil dual-in-line package
- Replaces 8 SSI and MSI packages

TMS5501 Multifunction I/O Controller For TMS8080A Systems



FEATURES

- Bus compatible with TMS8080A
- Addressed as memory by TMS8080A
- Major on-chip functions
  - —asynchronous communications interface 110 Baud to 9600 Baud
  - —five programmable interval timers 64μs to 16 ms
  - —8 bit output register
  - —8 bit external input port
  - —interrupt storage, masking and prioritization
- NMOS process
- 40 pin dual-in-line package

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TMS8080A
8-bit NMOS CPU

The TMS 8080A is an 8-bit microprocessor fabricated on a single chip using high-speed N-channel silicon gate technology. This same technology is used in manufacturing TI industry-standard 4K RAMs. A complete 8-bit microcomputer can be formed by interfacing the TMS 8080A with appropriate memory and interface circuits. A 16-bit address bus allows direct addressing of 65,536 bytes of memory, while an 8-bit data bus transfers data within the system. Up to 256 input and 256 output ports are directly addressable. Control signals are brought directly out of the processor, and all signals except for the clock are TTL compatible.

The TMS 8080A is supported by a complete family of compatible I/O peripherals, RAMS, ROMs, and PROMs. One of these, the TMS 5501, is a powerful and versatile Multifunction I/O Controller. The TMS 5501 provides the TMS 8080A system with an asynchronous communications interface, data I/O buffers, interval timers, and interrupt control logic. The TMS 5501 is controlled through TMS 8080A software providing a high degree of design flexibility.

Operation

- 8-bit parallel CPU
- Stack architecture uses portion of external memory as a push down stack for storing data from working registers and internal machine status
- Address and control lines select memory or I/O data locations
- Data bus transfers instructions or data
- IR holds current instructions until CONTROL completes execution sequence

Features

- 8-bit and 16-bit oriented instructions
- 6 general purpose internal registers
- 4 data addressing modes
- 16-bit stack pointer, plus memory-resident stack allows almost unlimited interrupt handling and subroutine nesting
- Simplified and interrupt handling through use of vectored interrupts
- WAIT and READY pins permit interfacing directly with different speed memories
- HOLD and HOLDA pins permit asynchronous DMA interface

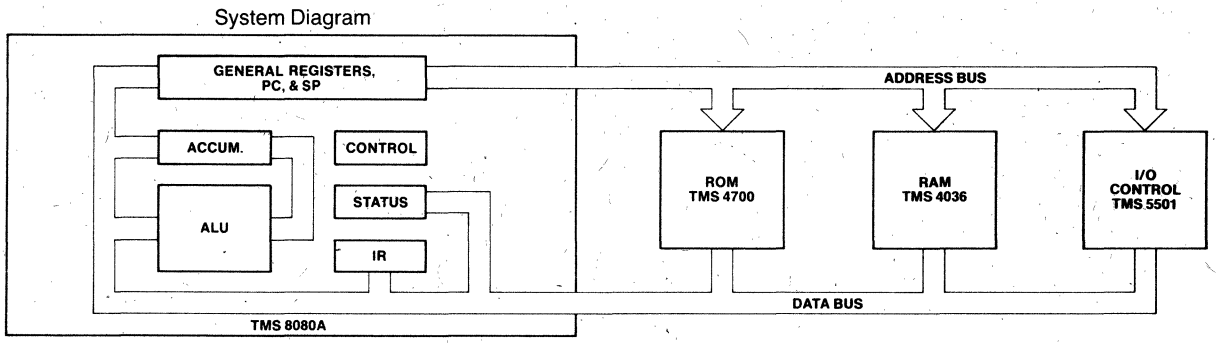
Characteristics

- 2μs minimum instruction cycle time
- 2MHz, 2-phase clock
- 16-bit address bus and 8-bit bidirectional data bus
- Addresses up to 65,536 bytes of memory
- Up to 256 input and 256 output ports
- 10 accessible internal registers
- 12V, 5V, and −5V power supplies
- TTL compatible logic levels

Design Support

- Assembler and simulator available on worldwide timeshare networks
- Complete documentation including data manuals, software manuals and application notes
- Video tape applications examples
- Field and factory located applications specialists
- I/O port SN74S412 (8212)
- Multifunction programmable I/O controller TMS 5501
- Clock driver SN74LS424 (8224)
- System controller SN74S428 (8228)
- 1024X8 bit EROM TMS 4908 (8708)

System Diagram



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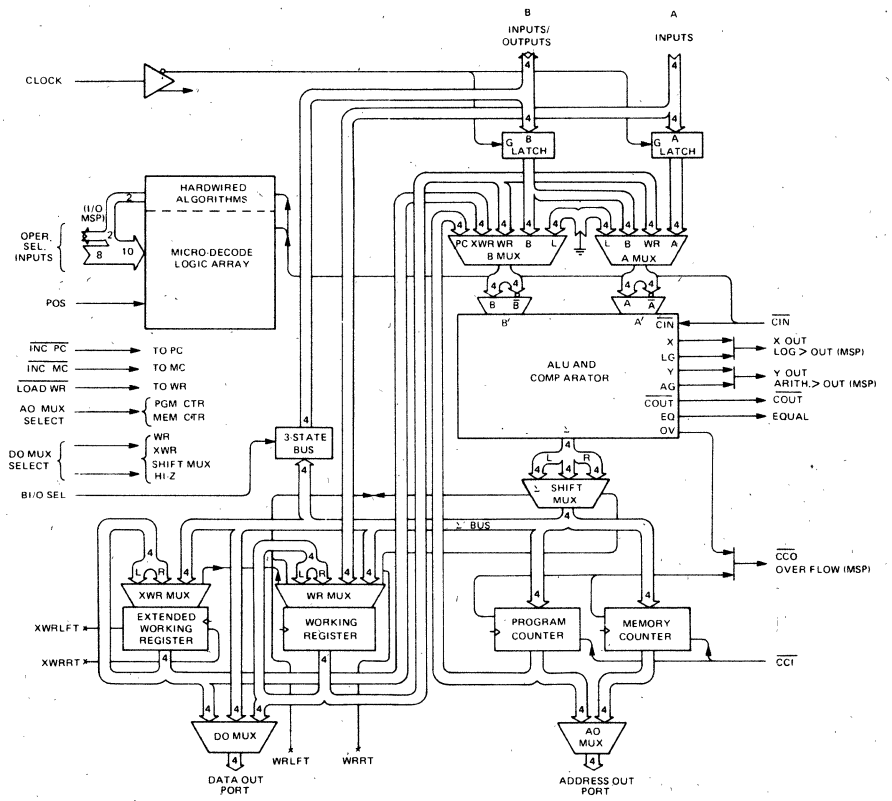
4-BIT-SLICE SCHOTTKY PROCESSOR ELEMENTS
SN54S481, SN74S481

- Expandable Processor Elements for High-Performance Computers and Controllers
- Advanced Memory-to-Memory Architecture
- Quad-Port Design for Maximum I/O Flexibility and Performance
- Dual Memory Address Generators on Chip
- Double-length Accumulator with Full Shifting Capability and Sign-Bit Handling
- Full Function ALU with Carry-Look Ahead, Magnitude and Overflow Decision Capability
- Simultaneous ALU/Shift/Control/Memory Operations with status Reduces Microcyles
- 24,780 Micro/Macro Instruction Capability Including Hardwired X, ÷ and CRG Algorithms
- 16-Bit X 16-Bit Double Precision Multiply in <3 μsec
- High-Density 48-Pin Quad-in-Line Package



'S481 FUNCTIONAL BLOCK DIAGRAM

The SN54S/74S481, with its hardwired algorithms, achieves the industry's highest degree of micro/macroprogrammability. Designed with full parallel dual input/output ports, its 4-bit memory-to-memory architecture provides a new dimension in interrupt processing or program context switching flexibilities. Its functional capability, characterized by the 24,780 unique operations, coupled with its modular expandability makes the 'S481 particularly attractive for implementing advanced high performance computers and controllers. Its static bipolar logic performs each microinstruction within a single 100 ns clock cycle.

In addition to the full parallel data bus structure, the 'S481 architecture also features asynchronous access to data routing and counter updating controls (see block diagram) which, when combined with the most versatile instruction set available (see operation summary) maximizes flexibility, efficiency, and performance. Simultaneous compound operations in the form of an ALU function with shift, plus destination selection with address/iteration updating, plus address *and* present data to memory can be accomplished in a single microcycle.

FORM	MICRO/MACRO – OPERATION FORMS	NO. OF OPS
I	A PLUS B PLUS ALUCIN → { Σ' BUS ONLY / WR, XWR, PC, OR MC }	4,096 / 8,192
II	B PLUS A PLUS ALUCIN DOUBLE-PRECISION SHIFTED → WR and XWR	384
III	A PLUS B PLUS ALUCIN SHIFTED → WR OR XWR	1,536
IV	A SHIFTED → Σ' BUS	192
V	{ WR / XWR } SHIFTED → { WR / XWR }	192 / 192
VI	WR AND XWR DOUBLE-PRECISION SHIFTED → WR AND XWR	256
VII	A : B OR B : A (COMPARE)	512
VIII	A { NOR / OR / EX-OR } B → WR, XWR, PC OR B IN/OUT	3,072 / 3,072 / 3,072
IX	ZERO → Σ' BUS (NO OP)	1
X	CRC CALCULATION (N CLK TIMES, CRC PARTIAL SUM IN WR)	1
XI	N-BIT QUOTIENT (WITH R) SIGNED DIVIDE (N+3 CLK TIMES)	5
XII	N-BIT QUOTIENT (WITH R) UNSIGNED DIVIDE (N+1 CLK TIMES)	3
XIII	N-BIT BY N-BIT DOUBLE-PRECISION UNSIGNED MULTIPLY (N CLK TIMES)	1
XIV	N-BIT BY N-BIT DOUBLE-PRECISION SIGNED MULTIPLY (N CLK TIMES)	1
	TOTAL OPERATIONS	24,780

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4-BIT-SLICE CONTROL ELEMENTS
SN54S482, SN74S482

FEATURES

- Expandable to N-bits in 4-bit-increments
- 25ns maximum address load time
- Space saving 20-pin package

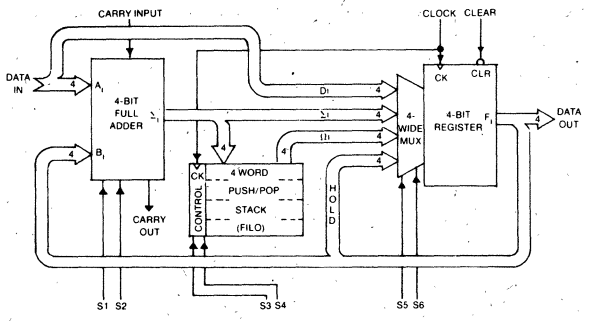
FUNCTIONS

- Generates forward or backward sequences
- Implements offset, vector, branch or jump
- Stores four return or link addresses
- Direct load to output register
- Holds or initializes system

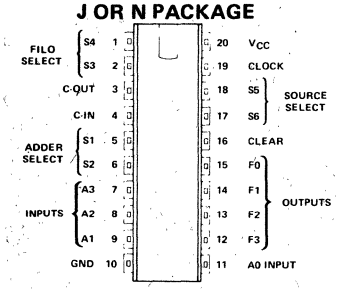
The SN54S/74S482 integrates a full adder, four-word push-pop stack, source select multiplexer and address register. All in a space saving 20-pin package. Its primary design use is to implement the next-address generator for microinstruction sequencing.

In addition to simple loops and forward sequences, the 'S482 can be used to implement the powerful operations needed to decrement, vector, offset or jump (in a single cycle) to any address within the domain of the controller.

Subroutines can be nested up to four levels deep in the 'S482's push-pop stack and be retrieved in the reverse order of occurrence. Moreover, the stack can be updated without changing the output register's contents.



SN54S482, SN74S482
J OR N PACKAGE



16-WORD BY 5-BIT FIFO MEMORY
SN74S225

FEATURES

- Expandable to N-Bits in 16-word increments
- DC to 10 MHz input or output data rate
- 3-State data output ports
- Direct clear for initializing
- Space saving 20-pin package

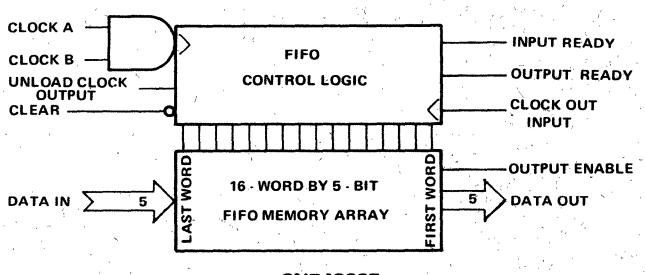
APPLICATIONS

- Buffer storage for interfacing:
  - Keyboard to line
  - Disc to tape
  - CPU to terminal
- Smooth or concentrate data rates

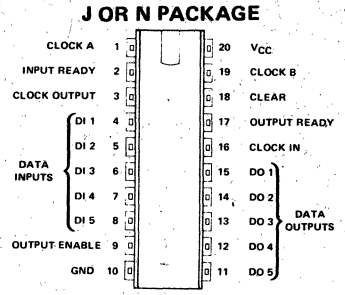
This 80-bit Schottky-clamped active-element first-in-first-out memory array, organized as 16 words of five bits each, includes full control logic to simplify interfacing processor systems with peripherals. The 'S225 can easily be expanded to 16N-words of 5N-bits in length. It features a single enable control for all 3-state data outputs and an asynchronous clear input to invalidate data stored in the memory array by clearing the control logic.

Utilizing separate synchronous clocks, data can be independently written into and/or read from this array at any desired clock rate from DC to 10 MHz. The data is processed in a parallel format, word by word.

Status of the 'S225 is decoded internally and is provided on three outputs. Input ready monitors the status of the last word location and signifies when the last word location is full. The unload clock output, also monitoring the last word location, generates a clock-out command in cascaded applications. The third status output, Output Ready, indicates when the first word location contains valid data.



SN74S225
J OR N PACKAGE



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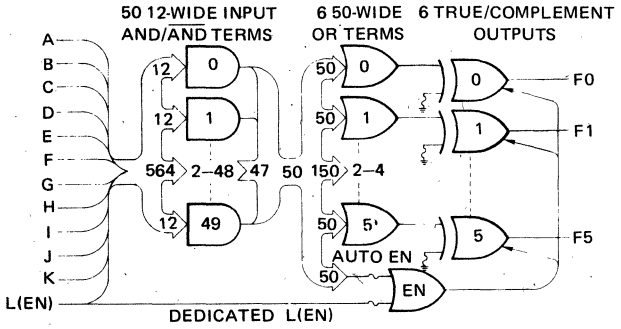
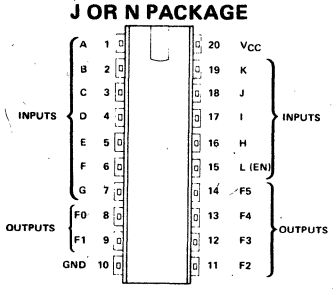
12-INPUT, 50-TERM, 6-OUTPUT FPLA'S
SN54S330/ 'S331, SN74S330/ 'S331

- Field-Programmable Logic Array Organized 12-Inputs/ 50-Product Terms/6-Outputs
- Active High or Low Inputs/Outputs
- Choice of Dedicated Enable or Automatic Enable for X-Y-Z Expansion of Inputs/Outputs and/or Product Terms
- Schottky Clamped for High-Performance:
  - 35 ns Typical Data Delay Time
  - 20 ns Typical Enable Time
- Reliable Ti-W Fuse Links for Fast, Low-Voltage Programming
- Choice of 3-State ('S330) or 2.5 kΩ Passive-Pullup ('S331) Outputs
- 'S331 Drives Low-Threshold MOS Directly
- High-Density 20-Pin Package

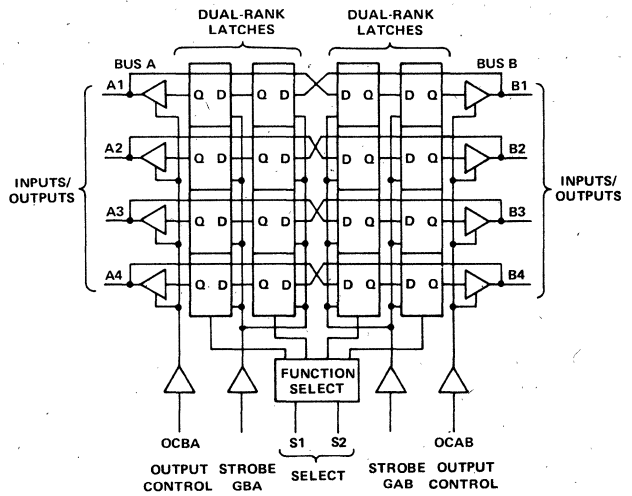


SN54S330/'S331, SN74S330/'S331
J OR N PACKAGE

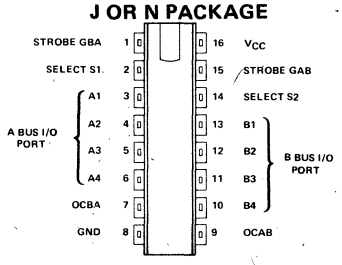


4-BIT LATCHED BUS TRANSCEIVERS
SN54S226, SN74S226

- Universal Transceivers for Implementing System Bus Controllers
- Dual-Rank 4-Bit Transparent Latches Provide
  - Exchange Data Between 2 Buses In One Clock Pulse
  - Bus-to-Bus Isolation
  - Rapid Data Transfer
  - Full Storage Capability
- Hysteresis at Data Inputs Enhances Noise Rejection
- Separate Output Control Inputs Provide Independent Enable/Disable for Either Bus Output
- 3-State Outputs Drive Bus Lines Directly



SN54S226, SN74S226
J OR N PACKAGE



INPUT/OUTPUT/INTERFACE CIRCUITS

TYPE	FUNCTION	COMMENT
SN54S/74S240	20-Pin Octal Inverting Bus Driver	Drives Highly Capacitive Data Bus/Address Lines
SN54S/74S241	20-Pin Octal Bus Buffer/Drivers	
SN54S/74S299	20-Pin Octal Serial/Parallel Register	Direct System Bus Interfaces with Storage
SN54S/74S373	20-Pin Octal Transparent Latches	
SN54S/74S374	20-Pin Octal D-Type Flip-Flops	
SN54S/74S412	24-Pin Octal Latches with Status F-F	8080A System Support Functions
SN74S428/'S438	28-Pin System/Bus Controller	

For complete specifications on TI's high-performance *Bipolar Microcomputer Components* write to: Texas Instruments Incorporated, P. O. Box 5012, M/S 308, Dallas, Texas 75222.

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SCHOTTKY TTL MEMORIES

- TI's Schottky-clamped memories offer:
  - Fast chip select/enable to simplify system decode
  - Wide choice of organizations
  - P-N-P inputs for reduced loading on system buffers/drivers
  - Full decoding with choice of three-state or open-collector outputs

RANDOM-ACCESS READ/WRITE MEMORIES

- Choice of speed/power ranges tailored for system requirements
- High-performance applications include: Local store/Work space/Buffer memory

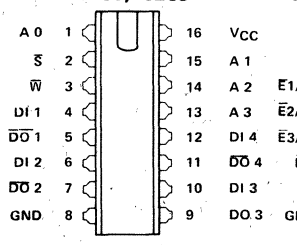
RAM PRODUCT LINE SUMMARY

TYPE NUMBER (PACKAGES)		BIT SIZE (ORGANIZATION)	OUTPUT CONFIGURATION	TYPICAL PERFORMANCE	
–55 C to 125 C	0 C to 70 C			ADDRESS ACCESS TIME	POWER DISSIPATION
SN54S189(J,W)	SN74S189(J,N)	64 bits (16 W x 4B)	Three-State	25 ns	375 mW
SN54S289(J,W)	SN74S289(J,N)		Open-Collector		
SN54S200A(J,W)	SN74S200A(J,N)	256 bits (256 W x 1B)	Three-State	25 ns	500 mW
SN54LS200A(J,W)	SN74LS200A(J,N)			35 ns	275 mW
SN54LS202(J,W)	SN74LS202(J,N)				275/100* mW
SN54S300A(J,W)	SN74S300A(J,N)		Open-Collector	25 ns	500 mW
SN54LS300A(J,W)	SN74LS300A(J,N)			35 ns	275 mW
SN54LS302(J,W)	SN74LS302(J,N)				275/100* mW
SN54S214(J)	SN74S214(J,N)	1024 bits (1024 W x 1B)	Three-State	30 ns	575 mW
SN54LS214(J)	SN74LS214(J,N)			65 ns	200 mW
SN54LS215(J)	SN74LS215(J,N)			65 ns	200/75* mW
SN54S314(J)	SN74S314(J,N)		Open-Collector	30 ns	575 mW
SN54LS314(J)	SN74LS314(J,N)			65 ns	200 mW
SN54LS315(J)	SN74LS315(J,N)			65 ns	200/75* mW
SN54S207(J)	SN74S207(J,N)	1024 bits (256 W x 4B)	Three-State	40 ns	600 mW
SN54LS207(J)	SN74LS207(J,N)			60 ns	300 mW
SN54S208(J)	SN74S208(J,N)			40 ns	600 mW
SN54LS208(J)	SN74LS208(J,N)			60 ns	300 mW

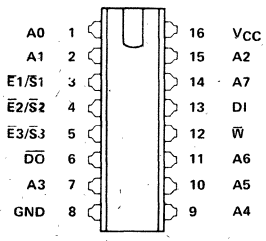
*Power Down

RAM PIN ASSIGNMENTS

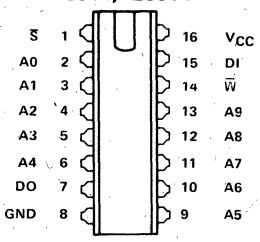
64-BITS (16 WORDS BY 4 BITS) 'S189, 'S289



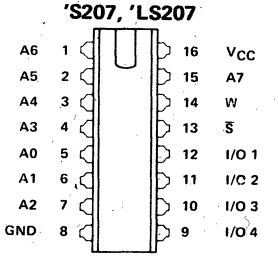
256-BITS (256 WORDS BY 1 BIT) 'S200A, 'LS200A, 'LS202, 'S300A, 'LS300A, 'LS302



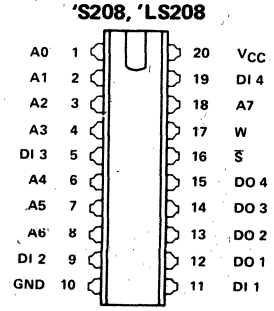
1024-BITS (1024 WORDS BY 1 BIT) 'S214, 'LS214, 'S314, 'LS314



1024-BITS (256 WORDS BY 4 BITS) 'S207, 'LS207



1024-BITS (256 WORDS BY 4 BITS) 'S208, 'LS208



PROGRAMMABLE READ-ONLY MEMORIES (PROM's)

- Titanium-Tungsten (Ti-W) fuse links for fast, low-voltage, reliable programming
- Applications include:
  - Microprogram/firmware loaders
  - Code converters/character generators
  - Address mapping/look-up tables

Full specifications for all Texas Instruments Schottky field-programmable read-only memories are provided in the MEMORY section of this *IC UPDATE MASTER.*

PROM ORGANIZATIONS/ACCESS TIMES

Organization	Type No. 3-State (O-C)	Access (Typ)
512-Words X 8-Bits	SN54S/74S472('S473)	55 ns
512-Words X 8-Bits	SN54S/74S474('S475)	55 ns
256-Words X 8-Bits	SN54S/74S471('S470)	50 ns
256-Words X 4-Bits	SN54S/74S287('S387)	42 ns
32-Words X 8-Bits	SN54S/74S288('S188)	25 ns

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BIPOLAR MICROCOMPUTER COMPONENTS

from Texas Instruments

- Variable hardware modularly expandable to virtually any system size
- Completely Microprogrammable for maximum software and memory efficiency
- Offers most flexible design solution for both commercial and military applications
- Maximum performance capability: SN74S481 microcycle time . . . . . 100 ns
  SBP0400AC/SBP0401AC microcycle time . . . . . 240/275 ns

This series of high complexity bipolar digital building blocks is designed specifically for implementing modularly expandable computer or controller systems with complete microprogrammability. The series offers a system designer the maximum flexibility for achieving cost-effective hardware designs from dedicated, highly specialized unique systems with tailored instructions to general-purpose computers capable of emulating existing machine instructions, or programs, without loss of software investment.

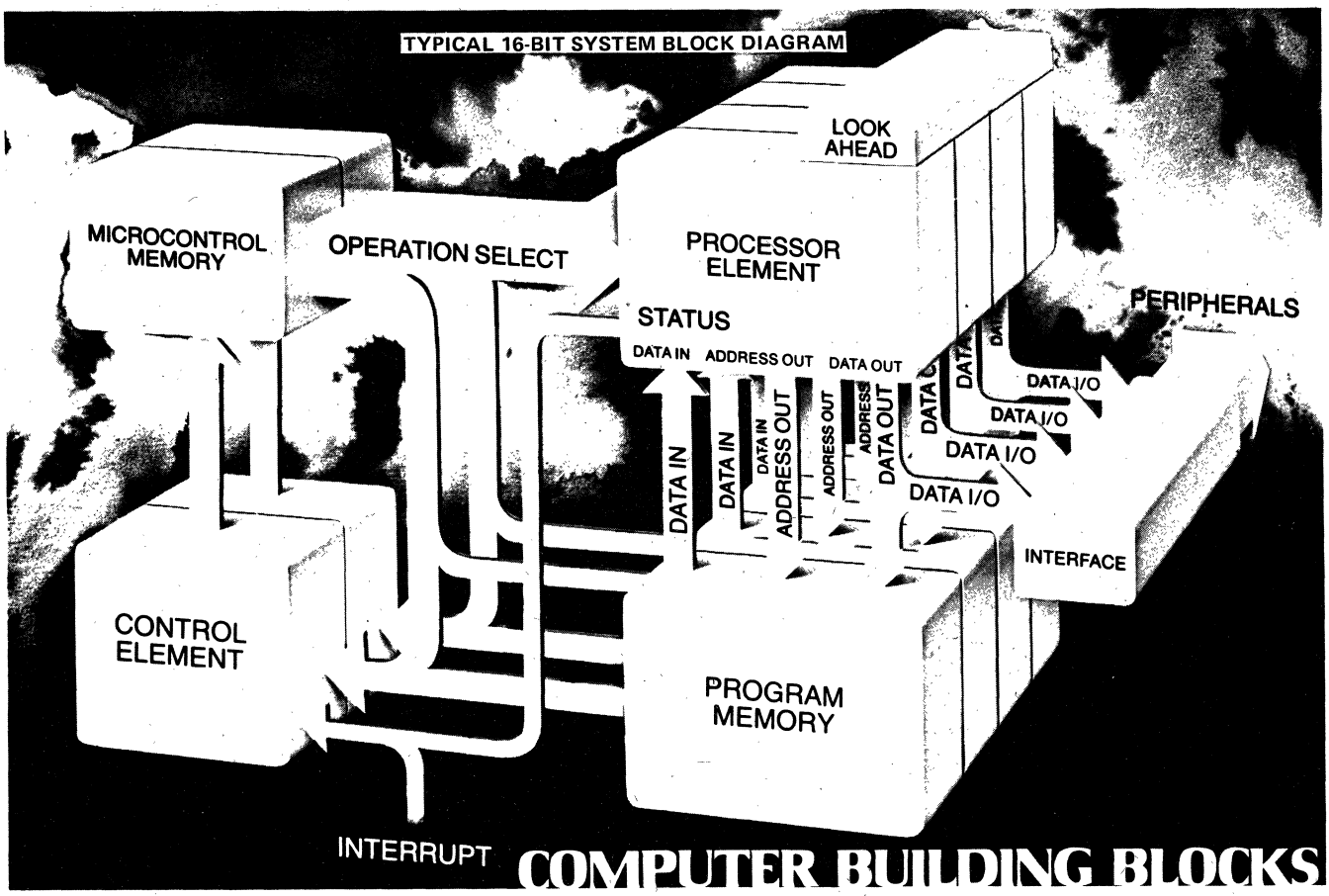
In addition to a choice between the high-performance Schottky† TTL 4-bit slice processor element or the unique performance flexibility of an I^2L 4-bit slice processor element, the system designer can pick from a full family of Schottky TTL memories (RAMs and PROMs), and state-of-the-art support functions needed to meet all control and interface requirements.

The SN54S/74S481, with a clock cycle time of 100 ns, is the industry's highest complexity Schottky TTL processor element, and the only bipolar micro/macro-programmable element featuring automatically sequenced iterative multiply and divide and cyclical-redundancy algorithms.

The SBP0400A and the SBP0401A, with complete TTL/MOS compatibility, can operate at a constant speed-power product over a wide range of supply current therein offering an unmatched level of performance flexibility.

The family of high-performance Schottky TTL memories offers a wide variety of organizations providing efficient solutions for virtually any size microcontrol or program memory.

System control is simplified to a very low package count with the expandable SN54S/74S482 4-bit slice controller performing next-address generation functions coupled with system status decoding performed by the industry's most versatile field-programmable logic arrays, the SN54S/74S330/'S331.



†Integrated Schottky-Barrier diode-clamped transistor is patented by Texas Instruments. U. S. Patent Number 3,463,975.

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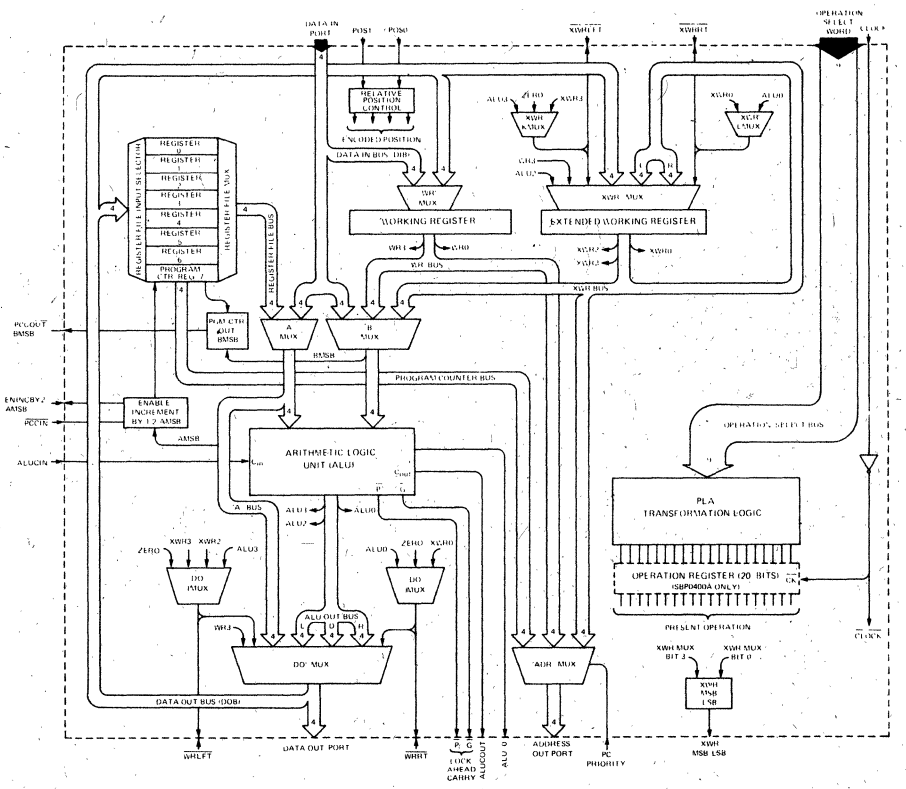
4-BIT-SLICE I^2L PROCESSOR ELEMENTS
SBP0400A, SBP0401A

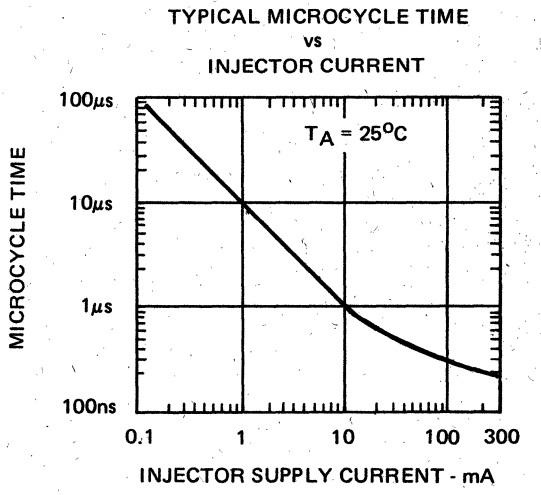
- I^2L Technology: User-Programmable Speed X Power Performance
- SBP0400A: On-Chip Operation Register for Control Bus Pipelining
- SBP0401A: Asynchronous Control Bus for SN74S482 Compatibility
- 8-Word Register File Includes Program Counter with Independent Word/Byte Incrementor
- Double-Length Accumulator with Full Bidirectional Shifting Capability and Sign-Bit Handling
- Full Function ALU with Carry-Look-Ahead, Zero-Result, and Operand Sign-Bit Status
- Compound ALU/Shift Operations, with XWR MSB and LSB Status, Simplifies Implementing Iterative Multiplies and Divides
- T^2L/Low-Power-Schottky/MOS Compatible I/O



'0400A/'0401A FUNCTIONAL BLOCK DIAGRAM

The SBP0400A and SBP0401A Processor Elements combine a versatile register-file bit-slice architecture with the unique properties of bipolar Integrated Injection Logic (I^2L) technology to offer a new dimension in design freedom beyond the conventional flexibilities of microprogrammable devices: *user-programmable speed X power performance*. Operating from virtually any d-c power source, these expandable 4-bit processor elements can be power-up/powered-down with complete maintenance of data integrity to perform data manipulations over a speed X power range spanning 3 orders of user-attenuated injector-supply-current magnitude (see graph).

Particularly attractive for power conservative equipment operating in both commercial and military temperature environments, the 40-pin dual-in-line packaged SBP0400A, and SBP0401A, are capable of executing any 1 of 512 microinstructions within a single 240 ns ('0400A) or 275 ns ('0401A) static clock cycle. In addition to efficient device access provided through parallel DATA-IN, DATA-OUT, and CONTROL ports; direct access to program-counter control facilities coupled with a dedicated ADDRESS-OUT port boosts system-level efficiency over multiplexed data/address port devices by allowing a complete memory access to be accomplished within a single microcycle.



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ABBREVIATIONS OF COMPANY NAMES

AD	Analog Devices
AMD	Advanced Micro Devices
AMI	American Microsystems, Inc.
AMS	Advanced Memory Systems (Intersil)
Analogic	Analogic Corp.
Beckman	Beckman Instruments, Helipot Division
Burr-Brown	Burr-Brown Research
Cermetek	Cermetek
CMA	Consumer Microcircuits of America
Collins	Collins, Rockwell International
Data Gen	Data General
Datel	Datel Systems
DDC	Data Devices Corp.
EA	Electronic Arrays
EMM/Semi	EMM Semi, Div. of Electronic Memories & Magnetics
Essex	Essex International
Exar	Exar Integrated Systems
Fairchild	Fairchild Semiconductor Systems
Ferranti	Ferranti Electric
Fujitsu	Fujitsu
GI	General Instrument
Harris	Harris Semiconductor
Hitachi	Hitachi America, Ltd.
Hughes	Hughes Aircraft, MOS Division
Hybrid Sys	Hybrid Systems
IMI	International Microcircuits, Inc.
Intech	Intech/Function Modules
Intel	Intel
Interdesign	Interdesign
Intersil	Intersil
IPI	Integrated Photomatrix, Inc.
ITT	ITT Semiconductors
Lithic Sys	Lithic Systems
Litronix	Litronix
LSI Comp	LSI Computer Systems
Micro Comp	Micro Components
Micro Net	Micro Networks
Micropac	Micropac Industries
Micro Power	Micro Power Systems
Mitel	Mitel Semiconductor
Mitsubishi	Mitsubishi International
MMI	Monolithic Memories, Inc.
MOS	MOS Technology
Mostek	Mostek
Motorola	Motorola Semiconductor
National	National Semiconductor
NCR	National Cash Register, Microelectronics Div.
NEC	NEC Microcomputers
Nippon	Nippon Electric Co.
Nitron	Nitron
Nortec	Nortec Electronics
NPC	Nucleonic Products Co.
Panasonic	Panasonic, Matsushita Electric Corp.
Plessey	Plessey Semiconductors
PMC	Power Monolithics Co.
PMI	Precision Monolithics, Inc.
Ragen	Ragen Semiconductor
Raytheon	Raytheon Semiconductor
RCA	RCA Solid State Division
Reticon	Reticon
Rockwell	Rockwell, Microelectronic Div.
Sanken	Sanken Electric
SGS	SGS-ATES Semiconductor
Siemens	Siemens
Signetics	Signetics
Silicon G	Silicon General
Siliconix	Siliconix
SMC	SMC Microsystems Corp.
SMS	Scientific Micro
Solitron	Solitron Devices
Sprague	Sprague Electric Company
SSS	Solid State Scientific
SW	Stewart-Warner Microcircuits
Synertek	Synertek
Teledyne C	Teledyne Crystalonics
Teledyne P	Teledyne Philbrick
Teledyne S	Teledyne Semiconductor
Telefunken	AEG-Telefunken
TI	Texas Instruments
TMX	TMX
Toshiba	Toshiba
TRW	TRW
Western	Western Digital
Zilog	Zilog

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ALTERNATE SOURCE DIRECTORY

The Alternate Source Directory is an industry wide cross reference of those devices which manufacturers claim are pin-for-pin and functional equivalents to IC's made by other firms. It is a compilation of many individual references and shows literally thousands of alternates that aren't implied by their model numbers, especially in the linear and memory areas. Unlike the usual alternate source guides this directory leads you to many alternate sources for any particular device, not just one. It is the most comprehensive alternate source directory ever published and contains over 19,000 cross references.

how to use the alternate source directory

The second column of this Alternate Source Directory shows devices which are replacements for those in the first column. Devices listed in **BOLD FACE** type have technical data in the Master Selection Guide. This information begins on the page listed to the right of the **BOLD FACE** part numbers. Products preceded by a ♦ have been discontinued by the manufacturer. This section does include devices not listed in the Master Selection Guide; e.g., discontinued items, consumer circuits, DTL and 54L devices.

This list is compiled from manufacturers' recommendations. Since there is a tendency for every company to only show itself as an alternate to the prominent manufacturers, and for the larger ones to ignore the little ones, not every device is referenced both ways to every other one. Therefore, if you are looking for alternates to a lesser known company's device, take the replacements you find, especially if they are made by prominent companies and look them up to see if you can find any other sources.

In order to maintain this list within some reasonable bounds, the A and B suffixes indicating improved versions generally have been dropped. If this weren't done, for example, every higher speed selection conjured up by a memory manufacturer would result in a device that could replace many equal or slower competitors and this directory would become highly involved in slight performance variations. Moreover, improved performance is only important if your circuits take advantage of it.

One of the difficulties with any cross reference is that devices meant to be alternates do not necessarily perform the same in all circuits. Thus, it will be necessary for you to check specifications, or even to check circuit performance before deciding which alternates are right for you. A major benefit of this list is that it gives you more alternatives to study. But if you don't find what you need here, it may be possible to find additional alternates by locating the device in the Master Selection Guide. Particularly for digital circuits, the other products grouped with it will normally offer similar or identical performance.

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Manufacturer Device	Replacement Source	Device	IC Master Page
Advanced Memory Systems			
AMS2650	Intersil	2650	
AMS6002	Intersil	6002	
AMS6003	Intersil	6003	
AMS7001	Intersil	7001	
AMS7003	Intersil	7003	
AMS7005	Intersil	7005	
AMS7008	Intersil	7008	
AMS7027	Intersil	7027	
AMS7101	Intersil	7101	
AMS7111	Intersil	7111	
AMS7112	Intersil	7112	
AMS7270	Intersil	7270	
AMS7271	Intersil	7271	
AMS7280	Intersil	7280	
Advanced Micro Devices			
♦AM2071	Signetics	82S07	
AM25LS07	TI	SN54LS378	
		SN74LS378	
AM25LS08	TI	SN54LS379	
		SN74LS379	
AM25LS09	TI	SN54LS399	
		SN74LS399	
AM25LS138	National	DM54LS138	
		DM74LS138	
	Raytheon	**25LS138**	**330**
AM25LS139	National	DM54LS139	
		DM74LS139	
	Raytheon	**25LS139**	**332**
AM25LS151	National	DM54LS151	
		DM74LS151	
	Raytheon	**25LS151**	**334**
AM25LS153	National	DM54LS153	
		DM74LS153	
	Raytheon	**25LS153**	**336**
AM25LS157	National	DM54LS157	
		DM74LS157	
	Raytheon	**25LS157**	**338**
AM25LS158	National	DM54LS158	
		DM74LS158	
	Raytheon	**25LS158**	**338**
AM25LS160	National	DM54LS160	
		DM74LS160	
	Raytheon	**25LS160**	**341**
AM25LS161	National	DM54LS161	
		DM74LS161	
	Raytheon	**25LS161**	**341**
AM25LS162	National	DM54LS162	
		DM74LS162	
	Raytheon	**25LS162**	**341**
AM25LS163	National	DM54LS163	
		DM74LS163	
	Raytheon	**25LS163**	**341**
AM25LS164	National	DM54LS164	
		DM74LS164	
AM25LS170	Raytheon	25LS170	
AM25LS174	National	DM54LS174	
		DM74LS174	
	Raytheon	**25LS174**	**344**
AM25LS175	National	DM54LS175	
		DM74LS175	
	Raytheon	**25LS175**	**344**
AM25LS181	National	DM54181	
		DM74181	
	Raytheon	**25LS181**	**346**
AM25LS190	National	DM54LS190	
		DM74LS190	
	Raytheon	**25LS190**	**350**
AM25LS191	National	DM54LS191	
		DM74LS191	
AM25LS192	**Raytheon**	**25LS192**	**353**
AM25LS193	National	DM54LS193	
		DM74LS193	
	Raytheon	**25LS193**	**353**
AM25LS194A	**Raytheon**	**25LS194A**	**355**
AM25LS195	**Raytheon**	**25LS195**	**355**
AM25LS22	TI	SN54LS322	
		SN74LS322	
AM25LS23	TI	SN54LS323	
		SN74LS323	
AM25LS251	**Raytheon**	**25LS251**	**334**
AM25LS253	**Raytheon**	**25LS253**	**336**
AM25LS257	National	DM54LS257	
		DM74LS257	
AM25LS258	National	DM54LS258	
		DM74LS258	
AM25L02	National	DM2502	
AM25L03	National	DM2503	
AM25L04	National	DM2504	
AM2502	National	DM2502	
AM2503	National	DM2503	
AM2504	National	DM2504	
AM2505	Raytheon	RC2505	
		RM2505	
	Signetics	2505	
AM26L02	National	DM8602	
		DM9602	
AM26L123	National	DM54L123	
		DM74L123	
AM26S02	National	DM8602	
		DM9602	
AM26S10	Fairchild	9640	
AM26S11	Fairchild	9641	
AM2602	National	DM8602	
		DM9602	
AM26123	National	DM54123	
		DM74123	
	TI	SN54123	
		SN74123	
AM27LS00	Fairchild	93421	
	National	**DM54S200**	**704**
		DM74S200	**704**
	TI	SN74LS200	
AM27LS01	Fairchild	93411	
	National	**DM54S206**	**751**
		DM74S206	**751**
AM27LS10	Fairchild	93416	
	Harris	HPROM1024	
	Intel	**3601**	**695**
AM27S02	Fairchild	93404	
	Intersil	IM5501	
	MMI	5560	
		6560	
	National	DM54S289	
		DM74S289	
	TI	SN54S289	
		SN74S289	
AM27S03	Fairchild	93405	
	MMI	5561	
		6561	
	National	**DM54S189**	**746**
		DM74S189	**746**
		DM7599	**704**
		DM8599	**704**
	TI	SN54S189	
		SN74S189	
AM27S08	**Harris**	**HM7602**	**682**
	National	**DM7577**	**702**
		DM8577	**702**
	Signetics	82S23	
	TI	**SN54S188**	**860**
		SN74S188	**860**
AM27S09	**Harris**	**HM7603**	**682**
	National	**DM7578**	**702**
		DM8578	**702**
	Signetics	82S123	
	TI	SN54S288	
		SN74S288	
AM27S10	**Harris**	**HM7610**	**682**
	Intel	M3601	
		3601	**695**
	National	**DM54S387**	**708**
		DM74S387	**708**
	TI	**SN54S387**	**861**
		SN74S387	**861**
AM27S11	**Harris**	**HM7611**	**682**
	Intel	M3621	
AM27S11	**Intel**	**3621**	**695**
	National	**DM54S287**	**708**
		DM74S287	**708**
	TI	**SN54S287**	**861**
		SN74S287	**861**
AM2700	Fairchild	93421	
	Intersil	IM5523	
	MMI	6531	
	Signetics	N82S16	
		82S06	
	TI	SN54S201	
		SN74S200A	
		SN74S201	
AM2701	Fairchild	93411	
	Intersil	IM5533	
	MMI	6530	
	Signetics	82S17	
	TI	SN54S301	
		SN74S300	
		SN74S301	
♦AM2715	Intersil	IM5523	
AM2802	Synertek	SY2802	
AM2803	Synertek	SY2803	
AM2804	Synertek	SY2804	
AM2806	Signetics	2512	
AM2807	Signetics	2524	
AM2808	Signetics	2525	
AM2809	Signetics	2521	
AM2814	TI	TMS3114	
AM2825	Synertek	SY5025	
AM2826	Synertek	SY5026	
AM2827	Synertek	SY2827	
AM2833	Signetics	2533	
	Synertek	SY2833	
	TI	TMS3133	
AM2901	Motorola	MC2901	
	Raytheon	AM2901	
AM2902	Raytheon	AM2902	
AM2905	Raytheon	AM2905	
AM2906	Raytheon	AM2906	
AM2907	Raytheon	AM2907	
AM2909	Motorola	MC2909	
	Raytheon	AM2909	
AM2911	Motorola	MC2911	
AM2915	Motorola	MC2915	
AM2916	Motorola	MC2916	
AM2917	Motorola	MC2917	
AM2918	Motorola	MC2918	
	Raytheon	AM2918	
LM101	**AD**	**AD101**	**575**
	Intersil	LM101	
	Motorola	MLM101	
	National	LM101	
	RCA	CA101	
	Signetics	LM101	
	Silicon G	SG101	
	Teledyne S	LM101	
LM105	Intersil	LM105	
	Motorola	MLM105	
	National	LM105	
	Raytheon	LM105	
	Silicon G	SG105	
	Teledyne S	LM105	
LM107	Intersil	LM107	
	Motorola	MLM107	
	National	LM107	
	Raytheon	LM107	
	RCA	CA107	
	Silicon G	SG107	
LM108	**AD**	**AD108**	**575**
	Intersil	LM108	
	Motorola	MLM108	
	National	LM108	
	Raytheon	LM108	
	Signetics	LM108	
	Silicon G	SG108	
LM110	Intersil	LM110	
	Motorola	MLM110	
	National	LM110	
	Silicon G	SG110	
LM111	Intersil	LM111	
LM111	Motorola	MLM111	
	National	LM111	
	Raytheon	LM111	
	RCA	CA111	
	Signetics	LM111	
	Silicon G	SG111	
	Teledyne S	LM111	
LM118	**AD**	**AD518**	**574**
	National	LM118	
	Raytheon	LM118	
LM201	**AD**	**AD201**	**575**
	Intersil	LM201	
	Motorola	MLM201	
	National	LM201	
	RCA	CA201	
	Signetics	LM201	
	Silicon G	SG201	
	Teledyne S	LM201	
LM202	Motorola	MLM210	
	Silicon G	SG202	
LM205	Intersil	LM205	
	Motorola	MLM205	
	Raytheon	LM205	
	Silicon G	SG205	
	Teledyne S	LM205	
LM207	Intersil	LM207	
	Motorola	MLM207	
	Raytheon	LM207	
	RCA	CA207	
	Silicon G	SG207	
LM208	**AD**	**AD208**	**575**
	Intersil	LM208	
	Motorola	MLM208	
	Raytheon	LM208	
	Silicon G	SG208	
LM210	Intersil	LM210	
	Motorola	MLM210	
	Silicon G	SG210	
LM211	Intersil	LM211	
	Motorola	MLM211	
	Raytheon	LM211	
	RCA	CA211	
	Signetics	LM211	
	Silicon G	SG211	
	Teledyne S	LM211	
LM218	**AD**	**AD518**	**574**
	Raytheon	LM218	
LM301	**AD**	**AD301**	**575**
	Intersil	LM301	
	Motorola	MLM301	
	Raytheon	LM301	
	RCA	CA301	
	Signetics	LM301	
	Silicon G	SG301	
	Teledyne S	LM301	
LM305	Intersil	LM305	
	Motorola	MLM305	
	Raytheon	LM305	
	Silicon G	SG305	
	Teledyne S	LM305	
LM307	Intersil	LM307	
	Motorola	MLM307	
	Raytheon	LM307	
	RCA	CA307	
	Signetics	LM307	
	Silicon G	SG307	
LM308	**AD**	**AD308**	**575**
	Intersil	LM308	
	Motorola	MLM308	
	Raytheon	LM308	
	Signetics	LM308	
	Silicon G	SG308	
LM310	Intersil	LM310	
	Motorola	MLM310	
	Silicon G	SG310	
LM311	Intersil	LM311	
	Motorola	MLM311	
	Raytheon	LM311	
	RCA	CA311	
	Signetics	LM311	
	Silicon G	SG311	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

IC MASTER

Advanced Micro Devices (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
LM311	Teledyne S	LM311	
LM318	**AD**	**AD518**	**574**
	Raytheon	LM318	
NE555	Motorola	MC1455	
	National	LM555	
	Silicon G	SG555	
SN54LS123	Raytheon	54LS123	
SN54LS138	**Raytheon**	**54LS138**	**254**
SN54LS139	**Raytheon**	**54LS139**	**254**
SN54LS151	**Raytheon**	**54LS151**	**256**
SN54LS153	**Raytheon**	**54LS153**	**258**
SN54LS157	**Raytheon**	**54LS157**	**262**
SN54LS158	**Raytheon**	**54LS158**	**262**
SN54LS160	**Raytheon**	**54LS160**	**264**
SN54LS161	**Raytheon**	**54LS161**	**264**
SN54LS162	**Raytheon**	**54LS162**	**264**
SN54LS163	**Raytheon**	**54LS163**	**264**
SN54LS170	Raytheon	54LS170	
SN54LS175	**Raytheon**	**54LS175**	**275**
SN54LS181	**Raytheon**	**54LS181**	**277**
SN54LS190	**Raytheon**	**54LS190**	**283**
SN54LS191	**Raytheon**	**54LS191**	**283**
SN54LS192	**Raytheon**	**54LS192**	**291**
SN54LS193	**Raytheon**	**54LS193**	**291**
SN54LS194A	**Raytheon**	**54LS194A**	**299**
SN54LS195A	**Raytheon**	**54LS195A**	**302**
SN54LS251	**Raytheon**	**54LS251**	**309**
SN54LS253	**Raytheon**	**54LS253**	**312**
SN54LS257	**Raytheon**	**54LS257**	**315**
SN54LS258	**Raytheon**	**54LS258**	**315**
SN54LS670	Raytheon	54LS670	
SN54S189	TI	SN54S189	
SN54181	Fairchild	9341	
	Raytheon	54181	
	TI	SN54181	
		SN74181	
SN54182	Fairchild	9342	
	Raytheon	54182	
	TI	SN54182	
		SN74182	
SN5489	Intersil	IM5501	
	MMI	5560	
	Raytheon	5489	
SN74LS123	Raytheon	74LS123	
SN74LS138	**Raytheon**	**74LS138**	**254**
SN74LS139	**Raytheon**	**74LS139**	**254**
SN74LS151	**Raytheon**	**74LS151**	**256**
SN74LS153	**Raytheon**	**74LS153**	**258**
SN74LS157	**Raytheon**	**74LS157**	**262**
SN74LS158	**Raytheon**	**74LS158**	**262**
SN74LS160	**Raytheon**	**74LS160**	**264**
SN74LS161	**Raytheon**	**74LS161**	**264**
SN74LS162	**Raytheon**	**74LS162**	**264**
SN74LS163	**Raytheon**	**74LS163**	**264**
SN74LS170	Raytheon	74LS170	
SN74LS175	**Raytheon**	**74LS175**	**275**
SN74LS181	**Raytheon**	**74LS181**	**277**
SN74LS190	**Raytheon**	**74LS190**	**283**
SN74LS191	**Raytheon**	**74LS191**	**283**
SN74LS192	**Raytheon**	**74LS192**	**291**
SN74LS193	**Raytheon**	**74LS193**	**291**
SN74LS194A	**Raytheon**	**74LS194A**	**299**
SN74LS195A	**Raytheon**	**74LS195A**	**302**
SN74LS251	**Raytheon**	**74LS251**	**309**
SN74LS253	**Raytheon**	**74LS253**	**312**
SN74LS257	**Raytheon**	**74LS257**	**315**
SN74LS258	**Raytheon**	**74LS258**	**315**
SN74LS670	Raytheon	74LS670	
SN74S160	Fairchild	93S10	
SN74S161	Fairchild	93S16	
SSS725	PMI	SSS725	
1002	Mostek	MK1002	
1101	Intersil	IM7501	
		IM7511	
	Mostek	MK4007	
1402	National	MM1402	
	Nortec	1402	
1402	Signetics	2502	
	Synertek	SY1402	
1403	National	MM1403	
	Nortec	1403	
	Signetics	2503	
	Synertek	SY1403	
1404	National	MM1404	
	Nortec	1404	
	Signetics	2504	
	Synertek	SY1404	
1488	Exar	XR1488	
	Motorola	MC1488	
	National	DS1488	
	Raytheon	RC1488	
	Silicon G	SG1488	
1489	Exar	XR1489	
	National	DS1489	
	Raytheon	RC1489	
	Silicon G	SG1489	
1500	Intersil	AM1500	
1501	Intersil	AM1501	
1507	Signetics	2506	
		2517	
1660	Intersil	AM166039	
1702	Mostek	MK3702	
2101	EA	EA2101	
		EA2101	
	Intel	2101	
	Intersil	7101	
	National	**MM2101**	**756**
	RCA	MW4101	
	Synertek	SY2101	
2102	Mostek	MK4102	
	National	**MM2102**	**759**
	Signetics	2102	
2111	EA	EA2111	
	Intel	2111	
	National	**MM2111**	**768**
	Synertek	SY2111	
2112	AMS	AMS7112	
	EA	EA2112	
	Intel	2112	
	Intersil	7112	
	National	**MM2112**	**771**
	Synertek	SY2112	
2401	Synertek	SY2401	
2702	Synertek	SY2102	
31L01	MMI	L5560	
		L6560	
	Signetics	N82S25	
31L0101	Intersil	IM5501	
	Signetics	N8225	
3101	AMI	S1685	
	Fairchild	93403	
	Intersil	IM5501	
	Signetics	82S25	
	TI	SN7489	
3101A	Signetics	3101A	
	TI	SN54S289	
		SN74S289	
3114	TI	TMS3114	
4102	Mostek	MK4102	
723	Intersil	723	
	Motorola	MC1723	
	Raytheon	RC723	
		RM723	
	RCA	CA723	
	Silicon G	SG723	
	Teledyne S	723	
725	PMI	SSS725	
733	Motorola	MC1733	
	Silicon G	SG733	
741	Intersil	741	
	Motorola	MC1741	
	PMI	OP-02	
		SSS741	
	Raytheon	RC741	
		RM741	
	RCA	CA741	
	Silicon G	SG741	
	Teledyne S	741	
747	Motorola	MC1747	
	PMI	OP-04	
		SSS747	
	Raytheon	RC747	
		RM747	
	RCA	CA747	
	Silicon G	SG747	
	Teledyne S	747	
748	Intersil	748	
	Motorola	MC1748	
	Raytheon	RC748	
		RM748	
	RCA	CA748	
	Silicon G	SG748	
	Teledyne S	748	
7552	Mostek	MK4102	
9050	RCA	MW4050	
9060	AMS	AMS7280	
	Intersil	7280	
	RCA	MW4060	
	Signetics	2680	
9080	Intel	8080	
	National	**DP8080A**	**1033**
	TI	**TMS8080**	**1097**
91L02	**National**	**MM2102**	**759**
	Signetics	21L02	
9101	AMS	AMS7101	
	Intersil	7101	
	National	**MM2101**	**756**
	RCA	MW4101	
9102	Mostek	MK4102	
	National	**MM2102**	**759**
	Signetics	2402	
	Synertek	SY2102	
	TI	TMS4033	
		TMS4034	
9111	AMS	AMS7111	
	Intersil	7111	
	National	**MM2111**	**768**
	RCA	MW4111	
9112	AMS	AMS7112	
	Intersil	7112	
	National	**MM2112**	**771**
	RCA	MW4112	
9208	Mostek	MK30000	
9214	Mostek	MK2600	
93L00	Fairchild	93L00	
93L01	Fairchild	93L01	
93L08	Fairchild	93L08	
93L09	Fairchild	93L09	
93L10	Fairchild	93L10	
93L11	Fairchild	93L11	
93L12	Fairchild	93L12	
93L14	Fairchild	93L14	
93L16	Fairchild	93L16	
93L18	Fairchild	93L18	
93L21	Fairchild	93L21	
93L22	Fairchild	93L22	
93L24	Fairchild	93L24	
93L28	Fairchild	93L28	
93L34	Fairchild	93L34	
93L38	Fairchild	93L38	
93L40	Fairchild	93L40	
93L41	Fairchild	93L41	
93L60	Fairchild	93L60	
	National	DM75L60	
		DM85L60	
93L66	Fairchild	93L66	
	National	DM75L63	
		DM85L63	
9300	Fairchild	9300	
	Raytheon	RM9300	
	TI	SN54195	
		SN74195	
9301	Fairchild	9301	
	TI	SN29301	
		SN39301	
9304	Fairchild	9304	
	Raytheon	RM9304	
9306	Fairchild	9306	
9308	Fairchild	9308	
9308	Raytheon	RM9308	
	TI	SN29308	
		SN39308	
9309	Fairchild	9309	
	TI	SN29309	
		SN39309	
9310	Fairchild	9310	
	Raytheon	RM9310	
	TI	SN54160	
		SN74160	
9311	Fairchild	9311	
	Raytheon	RM9311	
	TI	SN54154	
		SN74154	
9312	Fairchild	9312	
	Raytheon	RM9312	
	TI	SN29312	
		SN39312	
9314	Fairchild	9314	
9316	Fairchild	9316	
	Raytheon	RM9316	
	TI	SN54161	
		SN74161	
9318	Fairchild	9318	
	TI	SN54148	
		SN74148	
9321	Fairchild	9321	
9322	Fairchild	9322	
	Raytheon	RM9322	
	TI	SN54157	
		SN74157	
9324	Fairchild	9324	
9328	Fairchild	9328	
9334	Fairchild	9334	
	TI	SN54259	
		SN74259	
9338	Fairchild	9338	
9340	Fairchild	9340	
9341	Fairchild	9341	
	Raytheon	RM9341	
	TI	SN54181	
		SN74181	
93415	**Intel**	**2115**	**683**
	TI	SN54S314	
		SN74S314	
9342	Fairchild	9342	
	Raytheon	RM9342	
	TI	SN54182	
		SN74182	
9360	Fairchild	9360	
	Raytheon	RM9360	
9366	Fairchild	9366	
	Raytheon	RM9366	
9401	Synertek	SY2401	
96L02	Fairchild	96L02	
9600	Fairchild	9600	
9601	Fairchild	9601	
	Raytheon	RF9601	
	TI	SN29601	
9602	Fairchild	9602	
	Raytheon	RF9602	
9614	Fairchild	9614	
9615	Fairchild	9615	
9616	Fairchild	9616	
		9616	
9617	Fairchild	9617	
9620	Fairchild	9620	
9621	Fairchild	9621	
	Raytheon	RM9621	

American Microsystems, Inc.

Manufacturer Device	Replacement Source	Device	IC Master Page
S1103	Intel	1103	
S1413	SSS	SCL5430	
S146	Intel	1103-146	
	Signetics	2146	
♦S1670	Motorola	MC1160	
S1757	GI	AY3-1014	
		AY3-1015	
		AY5-1013	

♦ Discontinued

Bold face device numbers indicate manufacturers' data is provided in the IC Master on the pages noted.

Fairchild Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
µA732	Sprague	ULN-2120	
µA733	AMD	733	
	Motorola	MC1733	
	National	LM733	
	Raytheon	RC733	
		RM733	
	Signetics	µA733	
	Silicon G	SG733	
	TI	µA733	
µA734	Intersil	734	
µA739	SGS	TBA231	
µA740	Intersil	LH0042	
		740	
	Signetics	µA740	
µA741	AMD	741	
	Intersil	741	
	Motorola	MC1741	
	National	LM741	
	PMI	OP-02	
		PM741	
		SSS741	
	Raytheon	RC741	
		RM741	
	RCA	CA741	
	Signetics	µA741	
	Silicon G	SG741	
	Teledyne S	741	
	TI	µA741	
µA742	Exar	XR742	
µA746	National	LM746	
	RCA	CA3072	
	Sprague	ULN-2114	
µA747	AMD	747	
	Motorola	MC1747	
	National	LM747	
	PMI	OP-04	
		PM747	
		SSS747	
	Raytheon	RC747	
		RM747	
	RCA	CA747	
	Signetics	µA747	
	Silicon G	SG747	
	Teledyne S	747	
	TI	µA747	
µA748	AMD	748	
	Intersil	748	
	Motorola	MC1748	
	National	LM101	
		LM201	
		LM748	
	Raytheon	RC748	
		RM748	
	RCA	CA748	
	Signetics	µA748	
	Silicon G	SG748	
	Teledyne S	748	
	TI	µA748	
µA753	Sprague	ULN-2209	
µA754	National	LM1596	
µA758	Exar	XR1800	
	RCA	CA758	
	Signetics	µA758	
	Sprague	ULN-2244	
µA760	National	LM160	
µA763	National	LM1496	
µA767	Sprague	ULN-2128	
µA776	Silicon G	SG3250	
µA777	Intersil	777	
	Silicon G	SG777	
	TI	µA777	
µA78L05	Motorola	MC78L05	
	Signetics	µA78L05	
	TI	µA78L05	
µA78L08	Motorola	MC78L08	
	TI	µA78L08	
µA78L12	Motorola	MC78L12	
µA78L12	Signetics	µA78L12	
	TI	µA78L12	
µA78L15	Motorola	MC78L15	
	Signetics	µA78L15	
	TI	µA78L15	
µA78L26	Motorola	MC78L02	
		MC78L02	
	Signetics	µA78L26	
	TI	µA78L02	
µA78L62	Signetics	µA78L06	
	TI	µA78L06	
µA78M05	Motorola	MC78M05	
	Signetics	µA78M05	
	Silicon G	SG7805	
	TI	µA78M05	
µA78M06	Motorola	MC78M06	
	Signetics	µA78M06	
	Silicon G	SG7806	
µA78M08	Motorola	MC78M08	
	Signetics	µA78M08	
	TI	µA78M08	
µA78M12	Motorola	MC78M12	
	Signetics	µA78M12	
	Silicon G	SG7812	
	TI	µA78M12	
µA78M15	Motorola	MC78M15	
	Signetics	µA78M15	
	Silicon G	SG7815	
	TI	µA78M15	
µA78M20	TI	µA78M20	
µA78M24	Motorola	MC78M24	
	Signetics	µA78M24	
	Silicon G	SG7824	
	TI	µA78M24	
µA780	Sprague	ULN-2124	
µA7805	Motorola	MC7805	
	National	LM340-5	
	Signetics	µA7805	
	Silicon G	SG7805	
	TI	µA7805	
µA7806	Motorola	MC7806	
	National	LM340-6	
	Signetics	µA7806	
	Silicon G	SG7806	
	TI	µA7806	
		µA7806	
µA7808	Motorola	MC7808	
	National	LM340-8	
	Signetics	µA7808	
	Silicon G	SG7808	
	TI	µA7808	
µA781	Sprague	ULN-2127	
µA7812	Motorola	MC7812	
	National	LM340-12	
	Signetics	µA7812	
	Silicon G	SG7812	
	TI	µA7812	
µA7815	Motorola	MC7815	
	National	LM340-15	
	Signetics	µA7815	
	Silicon G	SG7815	
	TI	µA7815	
		µA7815	
µA7818	Motorola	MC7818	
	National	LM340-18	
	Signetics	µA7818	
	Silicon G	SG7818	
	TI	µA7818	
		µA7818	
µA7824	Motorola	MC7824	
	National	LM340-24	
	Signetics	µA7824	
	Silicon G	SG7824	
	TI	µA7824	
		µA7824	
µA786	SGS	TAA630	
µA7885	TI	µA7885	
µA79M05	TI	µA79M05	
µA79M06	TI	µA79M06	
µA79M08	TI	µA79M08	
µA79M12	TI	µA79M12	
µA79M15	TI	µA79M15	
µA79M20	TI	µA79M20	
µA79M24	TI	µA79M24	
µA7905	Motorola	MC7905	
	Silicon G	SG120-5	
	TI	µA7905	
µA7906	Motorola	MC7906	
	TI	µA7906	
µA7908	Motorola	MC7908	
	TI	µA7908	
µA7912	Motorola	MC7912	
	Silicon G	SG120-12	
	TI	µA7912	
µA7915	Motorola	MC7915	
	Silicon G	SG120-15	
	TI	µA7915	
µA7918	Motorola	MC7918	
	TI	µA7918	
µA7924	Motorola	MC7924	
	TI	µA7924	
µA795	Motorola	MC1495	
		MC1595	
µA796	Motorola	MC1496	
		MC1596	
		MC1596	
	Signetics	MC1496	
	Silicon G	SG1496	
		SG1596	
FM4027	Mostek	MK4027	
FQ3724	RCA	CA3724	
FQ3725	RCA	CA3725	
F10144	Signetics	10144	
F10405	TI	SN10147	
F10410	TI	SN10144	
F10415	Signetics	10146	
F4001	Harris	HD4001	
	National	CD4001	
	RCA	CD4001	
	SSS	SCL4001	
F4002	National	CD4002	
	RCA	CD4002	
	SSS	SCL4002	
F4006	Harris	HD4006	
	RCA	CD4006	
	SSS	SCL4006	
F4007	Harris	HD4007	
	RCA	CD4007	
	SSS	SCL4007	
F4008	Harris	HD4008	
	RCA	CD4008	
	SSS	SCL4008	
F40083	RCA	CD4008	
F40085	Harris	HD74C85	
	National	MM74C85	
	RCA	CD4063	
F40089	**National**	**MM74C89**	**805**
F40097	Harris	HD80C97	
	National	MM80C97	
F40098	National	MM80C98	
F4011	Harris	HD4011	
	National	CD4011	
	RCA	CD4011	
	SSS	SCL4011	
F4012	Harris	HD4012	
	National	CD4012	
	RCA	CD4012	
	SSS	SCL4012	
F4013	Harris	HD4013	
	National	CD4013	
	RCA	CD4013	
	SSS	SCL4013	
F4014	Harris	HD4014	
	National	CD4014	
	RCA	CD4014	
	SSS	SCL4014	
F4015	Harris	HD4015	
	National	CD4015	
	RCA	CD4015	
	SSS	SCL4015	
F4016	National	CD4016	
	RCA	CD4016	
F4016	SSS	SCL4016	
F40160	Harris	HD54C160	
		HD74C160	
	National	MM54C160	
		MM74C160	
	SSS	SCL4160	
	Teledyne S	MM74C160	
	TI	TP4360	
F40161	Harris	HD54C161	
		HD74C161	
	National	MM54C161	
		MM74C161	
	SSS	SCL4161	
	Teledyne S	MM74C161	
	TI	TP4361	
F40162	Harris	HD54C162	
		HD74C162	
	National	MM54C162	
		MM74C162	
	SSS	SCL4162	
	TI	TP4362	
F40163	Harris	HD54C163	
		HD74C163	
	National	MM54C163	
		MM74C163	
	SSS	SCL4163	
	Teledyne S	MM74C163	
	TI	TP4363	
F4017	Harris	HD4017	
	National	CD4017	
	RCA	CD4017	
	SSS	SCL4017	
F40174	Harris	HD54C174	
		HD74C174	
	National	MM54C174	
		MM74C174	
F40175	Harris	HD54C175	
		HD74C175	
	National	MM54C175	
		MM74C175	
F4018	Harris	HD4018	
	RCA	CD4018	
	SSS	SCL4018	
F4019	Harris	HD4019	
	National	CD4019	
	RCA	CD4019	
	SSS	SCL4019	
F40192	Harris	HD54C192	
		HD74C192	
	National	CD40192	
		MM54C192	
		MM74C192	
	RCA	CD40192	
	Teledyne S	MM74C192	
F40193	Harris	HD54C193	
		HD74C193	
	National	CD40193	
		MM54C193	
		MM74C193	
	RCA	CD40193	
	Teledyne S	MM74C193	
F40194	RCA	CD40194	
F40195	National	MM74C195	
F4020	Harris	HD4020	
	National	CD4020	
	RCA	CD4020	
	SSS	SCL4020	
F4021	Harris	HD4021	
	National	CD4021	
	RCA	CD4021	
	SSS	SCL4021	
F4022	Harris	HD4022	
	RCA	CD4022	
	SSS	SCL4022	
F4023	Harris	HD4023	
	National	CD4023	
	RCA	CD4023	
	SSS	SCL4023	
F4024	Harris	HD4024	
	National	CD4024	
	RCA	CD4024	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Fairchild Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Replacement Device	IC Master Page
F4024	SSS	SCL4024	
F4025	Harris	HD4025	
	National	CD4025	
	RCA	CD4025	
	SSS	SCL4025	
F4027	Harris	HD4027	
	National	CD4027	
	RCA	CD4027	
	SSS	SCL4027	
F4028	Harris	HD4028	
	RCA	CD4028	
	SSS	SCL4028	
F4029	Harris	HD4029	
	National	CD4029	
	RCA	CD4029	
	SSS	SCL4029	
F4030	Harris	HD4030	
	National	CD4030	
	RCA	CD4030	
		CD4070	
	SSS	SCL4030	
F4035	Harris	HD4035	
	National	CD4035	
	RCA	CD4035	
	SSS	SCL4035	
F4040	Harris	HD4040	
	National	CD4040	
	RCA	CD4040	
	SSS	SCL4040	
F4041	RCA	CD4041	
	SSS	SCL4041	
F4042	Harris	HD4042	
	National	CD4042	
	RCA	CD4042	
	SSS	SCL4042	
F4043	Harris	HD4043	
	RCA	CD4043	
	SSS	SCL4043	
F4044	Harris	HD4044	
	RCA	CD4044	
	SSS	SCL4044	
F4046	RCA	CD4046	
	SSS	SCL4046	
F4049	Harris	HD4049	
	National	CD4049	
	RCA	CD4049	
	SSS	SCL4049	
F4050	Harris	HD4050	
	National	CD4050	
	RCA	CD4050	
	SSS	SCL4050	
F4051	Harris	HD4051	
	RCA	CD4051	
	SSS	SCL4051	
F4052	Harris	HD4052	
	RCA	CD4052	
	SSS	SCL4052	
F4053	RCA	CD4053	
	SSS	SCL4053	
F4066	Harris	HD4066	
	National	CD4066	
	RCA	CD4066	
	SSS	SCL4066	
F4067	RCA	CD4067	
F4068	RCA	CD4068	
	SSS	SCL4068	
F4069	Harris	HD4069	
	RCA	CD4069	
	SSS	SCL4069	
F4070	Harris	HD4070	
	National	CD4070	
	RCA	CD4070	
	SSS	SCL4070	
F4071	RCA	CD4071	
	SSS	SCL4071	
F4072	RCA	CD4072	
	SSS	SCL4072	
F4073	RCA	CD4073	
	SSS	SCL4073	
F4075	RCA	CD4075	
	SSS	SCL4075	
F4076	RCA	CD4076	
	SSS	SCL4076	
F4077	RCA	CD4077	
	SSS	SCL4077	
F4078	RCA	CD4078	
	SSS	SCL4078	
F4081	Harris	HD4081	
	RCA	CD4081	
	SSS	SCL4081	
F4082	RCA	CD4082	
	SSS	SCL4082	
F4085	RCA	CD4085	
F4086	RCA	CD4086	
F4097	RCA	CD4097	
F4099	RCA	CD4099	
F4104	RCA	CD40104	
F4510	Harris	HD14510	
	RCA	CD4510	
	SSS	SCL4510	
F4511	RCA	CD4511	
	SSS	SCL4511	
F4512	Harris	HD14512	
	SSS	SCL4512	
F4514	RCA	CD4514	
	SSS	SCL4514	
F4515	RCA	CD4515	
	SSS	SCL4515	
F4516	Harris	HD14516	
	RCA	CD4516	
	SSS	SCL4516	
F4518	Harris	HD14518	
	RCA	CD4518	
	SSS	SCL4518	
F4519	Harris	HD14519	
F4520	Harris	HD14520	
	RCA	CD4520	
	SSS	SCL4520	
F4527	RCA	CD4527	
	SSS	SCL4527	
F4528	RCA	CD4098	
	SSS	SCL4528	
F4532	RCA	CD4532	
F4555	RCA	CD4555	
	SSS	SCL4555	
F4556	RCA	CD4556	
	SSS	SCL4556	
F4581	RCA	CD40181	
	SSS	SCL4581	
F4582	RCA	CD40182	
	SSS	SCL4582	
F4585	RCA	CD4063	
	SSS	SCL4585	
F4703	RCA	CD40105	
F4710	RCA	CD4036	
		CD4039	
F4720	RCA	CD40061	
		CD4061	
F4731	RCA	CD4031	
SH013	Intersil	IM5013	
SH3002	Siliconix	SI3002	
1103	**AMI**	**S1103A**	**634**
1800	SW	SW1800	
		SW1900	
	TI	SN151800	
		SN151900	
1802	SW	SW1802	
		SW1902	
	TI	SN151802	
		SN151902	
1805	TI	SN151805	
		SN151905	
1806	SW	SW1806	
		SW1906	
	TI	SN151806	
		SN151906	
1807	TI	SN151807	
		SN151907	
1808	SW	SW1808	
		SW1908	
	TI	SN151808	
		SN151908	
1810	SW	SW1810	
		SW1910	
	TI	SN151810	
		SN151910	
1812	SW	SW1812	
		SW1912	
	TI	SN151812	
		SN151912	
1814	SW	SW1814	
		SW1914	
2102	Mostek	MK4102	
	Signetics	21F02	
		2102	
2136	Motorola	MC1356	
	Sprague	ULN-2136	
3064	Motorola	MC1364	
	Sprague	ULN-2264	
3065	Motorola	MC1358	
	Sprague	ULN-2165	
3075	Motorola	MC1375	
	Sprague	ULN-2129	
3257	GI	RO5-2240S	
	Mostek	MK3202	
3260	**AMI**	**S8564**	**634**
3329	AMI	S1685	
3330	AMI	S1685	
3331	AMI	S1685	
3337	AMI	S1685	
3341	AMD	3341	
3342	TI	TMS3121	
3343	AMI	S2181	
	Signetics	2521	
3344	AMI	S2181	
	Signetics	2522	
3347	AMI	S2182	
	Intersil	IM7780	
	Signetics	2532	
	TI	TMS3120	
3348	TI	TMS3112	
3349	Signetics	2518	
	TI	TMS3122	
3355	Synertek	SY2833	
	TI	TMS3133	
34XXX	Fairchild	F4XXX	
3501	AMI	S8457	
	Collins	CRC3501	
	National	MM3501	
3507	AMI	S8773	
3512	AMI	S8773	
3513	AMI	S8773	
3514	**AMI**	**S3514**	**650**
		S8772	
	Mostek	MK2600	
	National	MM4233	
		MM5233	
3533	Signetics	2533	
3534	AMI	S2103	
3539	EMM/Semi	3539	
3580	AMI	S8773	
3705	Siliconix	SI3705	
3730	**AMI**	**S1757**	**400**
	GI	AY5-1013	
3731	**AMI**	**S1757**	**400**
3817	AMI	S1998	
3850	Mostek	3850	
3851	Mostek	3851	
3852	Mostek	3852	
3853	Mostek	3853	
3854	Mostek	3854	
3861	Mostek	MK3861	
4096	EA	EA4096	
	EMM/Semi	RO3-4096	
	GI	RO3-4096	
	Intersil	7005	
	Mostek	MK4096	
	Rockwell	1604	
54H00	Motorola	MC54H00	
54H00	Raytheon	54H00	
	Signetics	54H00	
	TI	SN54H00	
54H01	Motorola	MC54H01	
	Raytheon	54H01	
	Signetics	54H01	
	TI	SN54H01	
54H04	Motorola	MC54H04	
	Raytheon	54H04	
	Signetics	54H04	
	TI	SN54H04	
54H05	Motorola	MC54H05	
	Raytheon	54H05	
	Signetics	54H05	
	TI	SN54H05	
54H08	Motorola	MC54H08	
54H10	Motorola	MC54H10	
	Raytheon	54H10	
	Signetics	54H10	
	TI	SN54H10	
54H101	Motorola	MC54H101	
	TI	SN54H101	
54H102	Motorola	MC54H102	
	TI	SN54H102	
54H108	Motorola	MC54H108	
	TI	SN54H108	
54H11	Motorola	MC54H11	
	Raytheon	54H11	
	TI	SN54H11	
54H20	Motorola	MC54H20	
	Raytheon	54H20	
	Signetics	54H20	
	TI	SN54H20	
54H21	Motorola	MC54H21	
	TI	SN54H21	
54H22	Motorola	MC54H22	
	Raytheon	54H22	
	TI	SN54H22	
54H30	Motorola	MC54H30	
	Signetics	54H30	
	TI	SN54H30	
54H40	Motorola	MC54H40	
	Raytheon	54H40	
	Signetics	54H40	
	TI	SN54H40	
54H50	Motorola	MC54H50	
	TI	SN54H50	
54H51	Motorola	MC54H51	
	TI	SN54H51	
54H52	Motorola	MC54H52	
	TI	SN54H52	
54H53	Motorola	MC54H53	
	TI	SN54H53	
54H54	Motorola	MC54H54	
	TI	SN54H54	
54H55	Motorola	MC54H55	
	TI	SN54H55	
54H60	Motorola	MC54H60	
	TI	SN54H60	
54H61	Motorola	MC54H61	
	TI	SN54H61	
54H62	Motorola	MC54H62	
	TI	SN54H62	
54H71	Motorola	MC54H71	
	TI	SN54H71	
54H72	Motorola	MC54H72	
	TI	SN54H72	
54H73	Motorola	MC54H73	
	Signetics	54H73	
	TI	SN54H73	
54H74	Motorola	MC54H74	
	Raytheon	54H74	
	TI	SN54H74	
54H76	Signetics	54H76	
	TI	SN54H76	
54LS00	**Raytheon**	**54LS00**	**210**
54LS02	**Raytheon**	**54LS02**	**214**
54LS03	**Raytheon**	**54LS03**	**212**
54LS05	**Raytheon**	**54LS05**	**212**
54LS08	**Raytheon**	**54LS08**	**215**
54LS09	**Raytheon**	**54LS09**	**217**

♦ Discontinued

Bold face device numbers indicate manuracturers' data is provided in the IC Master on the pages noted.

American Microsystems, Inc. (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
S1757	Western	TR1402	
S1883	TI	TMS6011	
	Western	TR1602	
♦S2076	Intersil	IM7780	
♦S2102	Intersil	IM7552	
	Motorola	MCM6605	
S2181	Mostek	MK1002	
S2222	Nortec	2222	
	Signetics	N2222	
		S2222	
	SSS	SCM5522	
S2470	GI	AY1-1006	
S2555	Nitron	NC1183	
S2556	Nitron	NC1184	
♦S2566	Motorola	MC1182	
	Nitron	NC1182	
S2567	Nitron	NC1181	
S3102	SGS	M330	
	TI	TMS4035	
S3102A	TI	TMS4033	
S3102B	TI	TMS4034	
S3103	Nortec	1103	
S3514	Mostek	MK2600	
S4006	Mostek	MK4006	
S4008	Mostek	MK4008	
S4021	RCA	MW4060	
	TI	**TMS4060**	**854**
♦S4096	EA	EA4096	
	EMM/Semi	RO3-4096	
	Fairchild	4096	
	Mostek	MK4096	
	RCA	MW4104	
S5232	Mostek	MK2500	
		MK2600	
	National	MM5232	
S6800	Motorola	M6800	
S6810	Motorola	MCM6810	
S6820	Motorola	MC6820	
S6830	Motorola	MCM6830	
S6850	Motorola	MC6850	
S8865	GI	RO5-8192	
S8996	EMM/Semi	RO3-16384	
	GI	RO3-16384	
	Nortec	8996	

Analog Devices

Manufacturer Device	Replacement Source	Device	IC Master Page
AD101	AMD	LM101	
	Fairchild	μA101	
	Motorola	MLM101	
	National	LM101	
	RCA	CA101	
	Signetics	LM101	
	Silicon G	SG101	
	Teledyne S	LM101	
AD108	AMD	LM108	
	Fairchild	μA108	
	Motorola	MLM108	
	National	LM108	
	Raytheon	LM108	
	RCA	CA108	
	Signetics	LM108	
	Silicon G	SG108	
AD111	Motorola	MLM111	
	National	LM111	
	Raytheon	LM111	
	RCA	CA111	
	Signetics	LM111	
	Silicon G	SG111	
	Teledyne S	LM111	
AD201	AMD	LM201	
	Fairchild	μA201	
	Motorola	MLM201	
	National	LM201	
	RCA	CA201	
	Signetics	LM201	
AD201	Silicon G	SG201	
	Teledyne S	LM201	
AD208	AMD	LM208	
	Fairchild	μA208	
	National	LM208	
	Raytheon	LM208	
	RCA	CA208	
	Silicon G	SG208	
AD211	National	LM211	
	Raytheon	LM211	
	RCA	CA211	
	Signetics	LM211	
	Silicon G	SG211	
	Teledyne S	LM211	
AD301	AMD	LM301	
	Fairchild	μA301	
	Motorola	MLM301	
	National	LM301	
	Raytheon	LM301	
	RCA	CA301	
	Signetics	LM301	
	Silicon G	SG301	
	Teledyne S	LM301	
AD308	AMD	LM308	
	Fairchild	μA308	
	Motorola	MLM308	
	National	LM308	
	Raytheon	LM308	
	Signetics	LM308	
	Silicon G	SG308	
AD311	Motorola	MLM311	
	National	LM311	
	Raytheon	LM311	
	RCA	CA311	
	Signetics	LM311	
	Silicon G	SG311	
	Teledyne S	LM311	
AD503	National	LH0042	
	Teledyne S	2740	
AD506	National	LH0022	
AD507	Datel	AM-462	
	Harris	**HA-2620**	**581**
AD509	Datel	AM-452	
	Harris	**HA-2520**	**581**
AD513	National	LH0042	
AD516	National	LH0022	
AD559	Datel	DAC-IC8B	
	Motorola	MC1408	
		MC1508	
AD583	Datel	SHM-IC-1	
	Harris	**HA-2425**	**580**
AD710	Motorola	MC1710	
	National	LM710	
	Raytheon	RM710	
	Signetics	μA710	
	Silicon G	SG710	
	Teledyne S	710	
AD711	Motorola	MC1711	
	National	LM711	
	Raytheon	RM711	
	Signetics	μA711	
	Silicon G	SG711	
	Teledyne S	711	
AD741	AMD	741	
	Fairchild	μA741	
	Motorola	MC1741	
	National	LM741	
	PMI	SSS741	
	Raytheon	RM741	
	RCA	CA741	
	Signetics	μA741	
	Teledyne S	741	
AD7502	RCA	CD4052	
AD7505	Siliconix	DG507	
AD7506	**Harris**	**HI506**	**432**
	RCA	CD4067	
	Siliconix	DG506	
AD7507	**Harris**	**HI507**	**432**
	RCA	CD4097	
AD7513	Siliconix	DG200	

Beckman Instruments

Manufacturer Device	Replacement Source	Device	IC Master Page
877-80	Datel	DAC-HZ12B	
	Micro Net	DAC85	
877-85	Datel	DAC-HZ12B	
	Micro Net	DAC85	

Burr-Brown Research

Manufacturer Device	Replacement Source	Device	IC Master Page
ADC80	Micro Net	ADC80	
ADC85	Datel	ADC-HZ12	
	Micro Net	ADC85	
DAC12	AD	DAC12	
DAC80	Beckman	877-80	
	Datel	DAC-HZ12B	
	Micro Net	DAC80	
DAC85	Beckman	877-85	
	Datel	DAC-HZ12B	
	Micro Net	DAC85	
MPC16S	Datel	MX-1606	
	Harris	**HI506A**	**432**
MPC4D	Datel	MXD-409	
	Harris	**HI509A**	**432**
MPC8D	Datel	MXD-807	
	Harris	**HI507A**	**432**
MPC8S	Datel	MX-808	
	Harris	**HI508A**	**432**
SHC25	National	LH0023	
3500	AD	AD3500	
3503	**AD**	**AD540**	**574**
	Intersil	ICL3503	
3505	Datel	AM-450	
	Harris	**HA-2505**	**580**
3506	Datel	AM-460	
	Harris	**HA-2605**	**580**
3507	**AD**	**AD509**	**574**
	Datel	AM-452	
	Harris	**HA-2525**	**580**
3508	**AD**	**AD507**	**574**
	Datel	AM-462	
	Harris	**HA-2625**	**580**
♦3524	Intersil	ICL3524	
3542	AD	AD3542	
4201	**AD**	**AD530**	**576**
4205	**AD**	**AD532**	**576**
4213	**AD**	**AD532**	**576**
4550	Intersil	ICL4550	

Datel Systems

Manufacturer Device	Replacement Source	Device	IC Master Page
ADC-EK10B	Teledyne S	8701	
ADC-EK12B	Teledyne S	8702	
ADC-EK8B	Teledyne S	8700	
ADC-HZ12B	Burr-Brown	ADC80	
		ADC85	
	Micro Net	ADC80	
		ADC85	
AM-405	Harris	HA-2055	
AM-406	Harris	HA-2065	
AM-450	Burr-Brown	3505	
	Harris	**HA-2505**	**580**
AM-452	**AD**	**AD509**	**574**
	Burr-Brown	3507	
	Harris	**HA-2525**	**580**
	Teledyne P	TP1322	
AM-460	Burr-Brown	3506	
	Harris	**HA-2605**	**580**
AM-462	**AD**	**AD507**	**574**
	Burr-Brown	3508	
	Harris	**HA-2625**	**580**
	Teledyne P	TP1321	
AM-464	**Harris**	**HA-2645**	**580**
AM-490-2	**Harris**	**HA-2905**	**580**
AM-500	Teledyne P	TP1430	
DAC-HZ12B	Beckman	877-80	
	Burr-Brown	DAC80	
	Micro Net	DAC80	
DAC-HZ12BM	Beckman	877-85	
DAC-HZ12BM	Burr-Brown	DAC85	
	Micro Net	DAC85	
MX-1606	**Harris**	**HI506A**	**432**
MX-808	**Harris**	**HI508A**	**432**
MXD-409	**Harris**	**HI509A**	**432**
MXD-807	**Harris**	**HI507A**	**432**
SHM-IC-1	**AD**	**AD583**	**579**
	Harris	**HA-2425**	**580**
	Teledyne P	TP4856	

Electronic Arrays

Manufacturer Device	Replacement Source	Device	IC Master Page
EA1004	TI	TMS3003	
EA1009	AMI	S2181	
♦EA1012	TI	TMS3002	
EA1206	AMI	S1685	
EA12065	AMI	S1685	
EA12105	AMI	S1685	
EA1212	AMI	S1685	
EA1400	**AMI**	**S4006**	**634**
EA2102	Mostek	MK4102	
	TI	TMS4035	
♦EA3000	AMI	S8773	
♦EA3001	AMI	S8773	
♦EA3100	AMI	S8773	
♦EA3101	AMI	S8773	
♦EA3132	AMI	S8773	
♦EA3300	AMI	S8772	
♦EA3307	AMI	S8772	
EA3800	AMI	S8773	
EA4000	**AMI**	**S8771**	**634**
	GI	RO3-5120	
EA4004	**AMI**	**S8771**	**634**
EA4015	**AMI**	**S8771**	**634**
EA4016	**AMI**	**S8771**	**634**
EA4096	EMM/Semi	RO3-4096	
	Fairchild	4096	
	GI	RO3-4096	
	Mostek	MK4096	
	Rockwell	1604	
EA4800	TI	TMS4800	
EA4900	Mostek	MK28000	
	TI	TMS4800	
EA5316	AMI		
		S1998	
RA3-4256	GI	RA3-4256	
RO3-16384	GI	RO3-16384	
RO3-4096	GI	RO3-4096	
RO3-4402	GI	RO3-4402	
RO3-5120	GI	RO3-5120	
RO3-8316A	Intel	8316A	
RO3-8316B	Intel	2316B	
		8316B	
1217	GI	RA3-1217	
1218	GI	RA3-1218	
4104A	Nitron	NC4104A	
4200	GI	RA3-4200	
	Nitron	NC4200	
4402A	Nitron	NC4402A	
4402B	Nitron	NC4402B	

Exar Integrated Systems

Manufacturer Device	Replacement Source	Device	IC Master Page
XR1310	Motorola	MC1310	
	National	LM1310	
XR1800	National	LM1800	
XR2207	Raytheon	XR2207	
XR2211	Raytheon	XR2211	
XR2240	Fairchild	7240	
	Intersil	8240	
XR2556	Teledyne S	D555	
XR2567	Raytheon	XR2567	
XR3503	Motorola	MC3503	
	Raytheon	**RM3503**	**586**
XR4136	**Raytheon**	**RC4136**	**588**
XR4151	**Raytheon**	**RC4151**	**590**
		RM4151	**590**
		RV4151	**590**
XR4152	Raytheon	RC4152	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Exar Integrated Systems (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
XR4152	Raytheon	RM4152	
		RV4152	
XR4156	**Raytheon**	**RC4156**	**592**
		RM4156	**592**
		RV4156	
XR4194	**Raytheon**	**RC4194**	**594**
XR4212	**Harris**	**HA-4741**	**580**
XR4558	Motorola	MC4558	
	Raytheon	RC4558	
XR555	Lithic Sys	LS555	
	Motorola	MC1455	
XR556	Motorola	MC3456	
	Raytheon	RC556	
	Teledyne S	556	
XR742	Fairchild	μA742	

Fairchild Semiconductor

Manufacturer Device	Replacement Source	Device	IC Master Page
μAF355	Motorola	LF355	
μAF356	Motorola	LF356	
μAF357	Motorola	LF357	
μA101	AMD	LM101	
	Intersil	LM101	
	Motorola	MLM101	
	National	LM101	
	RCA	CA101	
	Signetics	LM101	
	Silicon G	SG101	
	Teledyne S	LM101	
	TI	LM101	
μA102	AMD	LM102	
	Intersil	LM102	
	Motorola	MLM110	
	National	LM102	
	Silicon G	SG102	
μA104	Motorola	MLM104	
	National	LM104	
	Raytheon	LM104	
	Silicon G	SG104	
	Teledyne S	LM104	
	TI	LM104	
μA105	AMD	LM105	
	Intersil	LM105	
	Motorola	MLM105	
	National	LM105	
	Raytheon	LM105	
	Silicon G	SG105	
	Teledyne S	LM105	
	TI	LM105	
μA107	AMD	LM107	
	Intersil	LM107	
	Motorola	MLM107	
	National	LM107	
	Raytheon	LM107	
	RCA	CA107	
	Signetics	LM107	
	Silicon G	SG107	
	TI	LM107	
μA108	AMD	LM108	
	Intersil	LM108	
	Motorola	MLM108	
	National	LM108	
	PMI	PM108	
	Raytheon	LM108	
	RCA	CA108	
	Signetics	LM108	
	Silicon G	SG108	
μA109	Motorola	MLM109	
	National	LM109	
	Raytheon	LM109	
	Silicon G	SG109	
	TI	LM109	
μA110	AMD	LM110	
	Intersil	LM110	
	Motorola	MLM110	
	National	LM110	
μA110	Silicon G	SG110	
μA111	AMD	LM111	
	Intersil	LM111	
	Raytheon	LM111	
	RCA	CA111	
	Signetics	LM111	
	Silicon G	SG111	
	Teledyne S	LM111	
	TI	LM111	
μA139	AMD	LM139	
	RCA	CA139	
	Silicon G	SG139	
	TI	LM139	
μA1391	Motorola	MC1391	
μA1394	Motorola	MC1394	
μA1458	AMD	1458	
	Harris	**HA-2655**	**580**
	Motorola	MC1458	
	National	LM1458	
	Raytheon	RC1458	
	RCA	CA1458	
	Signetics	MC1458	
	Silicon G	SG1458	
	Teledyne S	1458	
	TI	MC1458	
μA1558	AMD	1558	
	Harris	**HA-2650**	**581**
	Motorola	MC1558	
	National	LM1558	
	Raytheon	RM1558	
	Signetics	MC1558	
	Silicon G	SG1558	
	Teledyne S	1558	
	TI	MC1558	
μA201	AMD	LM201	
	Intersil	LM201	
	Motorola	MLM201	
	National	LM201	
	RCA	CA201	
	Signetics	LM201	
	Silicon G	SG201	
	Teledyne S	LM201	
	TI	LM201	
μA202	Intersil	LM202	
	Motorola	MLM210	
	Silicon G	SG202	
μA204	Motorola	MLM204	
	Silicon G	SG204	
	Teledyne S	LM204	
	TI	LM204	
μA205	Intersil	LM205	
	Motorola	MLM205	
	National	LM205	
	Raytheon	LM205	
	Silicon G	SG205	
	Teledyne S	LM205	
	TI	LM205	
μA207	AMD	LM207	
	Intersil	LM207	
	Motorola	MLM207	
	National	LM207	
	Raytheon	LM207	
	RCA	CA207	
	Signetics	LM207	
	Silicon G	SG207	
	TI	LM207	
μA208	AMD	LM208	
	Intersil	LM208	
	Motorola	MLM208	
	National	LM208	
	PMI	PM208	
	Raytheon	LM208	
	RCA	CA208	
	Signetics	LM208	
	Silicon G	SG208	
μA209	Motorola	MLM209	
	National	LM209	
	Raytheon	LM209	
	Silicon G	SG209	
	TI	LM209	
μA210	Intersil	LM210	
μA210	Motorola	MLM210	
	Silicon G	SG210	
μA211	Intersil	LM211	
	National	LM211	
	Raytheon	LM211	
	RCA	CA211	
	Signetics	LM211	
	Silicon G	SG211	
	Teledyne S	LM211	
	TI	LM211	
μA301	AMD	LM301	
	Intersil	LM301	
	Motorola	MLM301	
	National	LM301	
	Raytheon	LM301	
	RCA	CA301	
	Signetics	LM301	
	Silicon G	SG301	
	Teledyne S	LM301	
	TI	LM301	
μA3018	Lithic Sys	LA3018	
μA302	AMD	LM302	
	Intersil	LM302	
	Motorola	MLM310	
	Silicon G	SG302	
μA3026	Lithic Sys	LA3026	
μA304	Motorola	MLM304	
	National	LM304	
	Raytheon	LM304	
	Silicon G	SG304	
	Teledyne S	LM304	
	TI	LM304	
μA3045	Lithic Sys	LA3045	
	Silicon G	SG3045	
μA3046	Lithic Sys	LA3046	
	Silicon G	SG3046	
μA305	AMD	LM305	
	Intersil	LM305	
	Motorola	MLM305	
	National	LM305	
	Raytheon	LM305	
	Silicon G	SG305	
	Teledyne S	LM305	
	TI	LM305	
μA306	National	LM306	
	Raytheon	LM306	
μA3064	National	LM3064	
μA3065	National	LM3065	
μA307	AMD	LM307	
	Intersil	LM307	
	Motorola	MLM307	
	National	LM307	
	Raytheon	LM307	
	RCA	CA307	
	Signetics	LM307	
	Silicon G	SG307	
	TI	LM307	
μA308	AMD	LM308	
	Intersil	LM308	
	Motorola	MLM308	
	National	LM308	
	PMI	PM308	
	Raytheon	LM308	
	RCA	CA308	
	Signetics	LM308	
	Silicon G	SG308	
μA3086	Lithic Sys	LA3086	
	Silicon G	SG3886	
μA3089	Sprague	ULN-2289	
μA309	Motorola	MLM309	
	Silicon G	SG309	
	TI	LM309	
μA310	AMD	LM310	
	Intersil	LM310	
	Motorola	MLM310	
	Silicon G	SG310	
μA311	AMD	LM311	
	Intersil	LM311	
	Motorola	MLM311	
	Raytheon	LM311	
	RCA	CA311	
μA311	Signetics	LM311	
	Silicon G	SG311	
	Teledyne S	LM311	
	TI	LM311	
μA339	AMD	LM339	
	RCA	CA339	
	Silicon G	SG339	
	TI	LM399	
μA3401	Motorola	MC3401	
	RCA	CA3401	
μA3403	Motorola	MC3403	
		MC3403	
	Raytheon	**RC3403**	**586**
μA3503	Motorola	MC3503	
		MC3503	
	Raytheon	**RM3503**	**586**
μA376	Teledyne S	LM376	
	TI	LM376	
μA4136	**Raytheon**	**RC4136**	**588**
	TI	RC4136	
μA555	Motorola	MC1455	
	Raytheon	RC555	
	Signetics	NE555	
	Silicon G	SG555	
	TI	NE555	
μA556	Motorola	MC3456	
	Raytheon	RC556	
	Signetics	NE556	
	Silicon G	SG556	
	TI	NE556	
μA702	Motorola	MC1712	
	Raytheon	RC702	
		RM702	
	TI	μA702	
μA703	National	LM703	
μA705	Sprague	ULN-2278	
μA706	SGS	TBA641	
μA709	Motorola	MC1709	
	National	LM709	
	Raytheon	RC709	
		RM709	
	Signetics	μA709	
	Teledyne S	709	
	TI	μA709	
μA710	Motorola	MC1710	
	National	LM710	
	Raytheon	RC710	
		RM710	
	Signetics	μA710	
	Silicon G	SG710	
	Teledyne S	710	
	TI	μA710	
μA711	Motorola	MC1711	
	National	LM711	
	Raytheon	RC711	
		RM711	
	Signetics	μA711	
	Silicon G	SG711	
	Teledyne S	711	
	TI	μA711	
μA715	AMD	715	
μA720	Sprague	ULN-2137	
μA723	AMD	723	
	Intersil	723	
	Motorola	MC1723	
	National	LM723	
	Raytheon	RC723	
		RM723	
	RCA	CA723	
	SGS	L123	
	Signetics	μA723	
	Silicon G	SG723	
	Teledyne S	723	
	TI	μA723	
μA7240	Exar	XR2240	
μA725	AMD	725	
	PMI	SSS725	
	Raytheon	RC725	
		RM725	
μA729	Sprague	ULN-2122	
μA732	National	LM1305	

♦ Discontinued

Bold face device numbers indicate manufacturers' data is provided in the IC Master on the pages noted.

Fairchild Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
54LS10	**Raytheon**	**54LS10**	**210**
54LS109	**Raytheon**	**54LS109**	**251**
54LS11	**Raytheon**	**54LS11**	**215**
54LS112	**Raytheon**	**54LS112**	**232**
54LS113	**Raytheon**	**54LS113**	**232**
54LS114	**Raytheon**	**54LS114**	**237**
54LS138	**Raytheon**	**54LS138**	**254**
54LS139	**Raytheon**	**54LS139**	**254**
54LS14	**Raytheon**	**54LS14**	**218**
54LS15	**Raytheon**	**54LS15**	**217**
54LS151	**Raytheon**	**54LS151**	**256**
54LS152	**Raytheon**	**54LS152**	**256**
54LS153	**Raytheon**	**54LS153**	**258**
54LS155	**Raytheon**	**54LS155**	**260**
54LS156	**Raytheon**	**54LS156**	**260**
54LS157	**Raytheon**	**54LS157**	**262**
54LS158	**Raytheon**	**54LS158**	**262**
54LS160	**Raytheon**	**54LS160**	**264**
54LS161	**Raytheon**	**54LS161**	**264**
54LS162	**Raytheon**	**54LS162**	**264**
54LS163	**Raytheon**	**54LS163**	**264**
54LS164	**Raytheon**	**54LS164**	**271**
54LS170	Raytheon	54LS170	
54LS174	**Raytheon**	**54LS174**	**275**
54LS175	**Raytheon**	**54LS175**	**275**
54LS181	**Raytheon**	**54LS181**	**277**
54LS190	**Raytheon**	**54LS190**	**283**
54LS191	**Raytheon**	**54LS191**	**283**
54LS192	**Raytheon**	**54LS192**	**291**
54LS193	**Raytheon**	**54LS193**	**291**
54LS194A	**Raytheon**	**54LS194A**	**299**
54LS195A	**Raytheon**	**54LS195A**	**302**
54LS196	**Raytheon**	**54LS196**	**305**
54LS197	**Raytheon**	**54LS197**	**305**
54LS20	**Raytheon**	**54LS20**	**210**
54LS21	**Raytheon**	**54LS21**	**215**
54LS22	**Raytheon**	**54LS22**	**212**
54LS251	**Raytheon**	**54LS251**	**309**
54LS253	**Raytheon**	**54LS253**	**312**
54LS255	**Raytheon**	**54LS255**	**313**
54LS257	**Raytheon**	**54LS257**	**315**
54LS258	**Raytheon**	**54LS258**	**315**
54LS26	**Raytheon**	**54LS26**	**222**
54LS266	**Raytheon**	**54LS266**	**253**
54LS27	**Raytheon**	**54LS27**	**214**
54LS279	Raytheon	54LS279	
54LS283	Raytheon	54LS283	
54LS295	**Raytheon**	**54LS295A**	**321**
54LS298	**Raytheon**	**54LS298**	**323**
54LS30	**Raytheon**	**54LS30**	**210**
54LS32	**Raytheon**	**54LS32**	**225**
54LS365	**Raytheon**	**54LS365**	**325**
54LS366	**Raytheon**	**54LS366**	**325**
54LS367	Raytheon	54LS367	
54LS368	Raytheon	54LS368	
54LS37	**Raytheon**	**54LS37**	**223**
54LS38	**Raytheon**	**54LS38**	**226**
54LS40	**Raytheon**	**54LS40**	**223**
54LS42	**Raytheon**	**54LS42**	**227**
54LS51	**Raytheon**	**54LS51**	**230**
54LS54	**Raytheon**	**54LS54**	**230**
54LS55	**Raytheon**	**54LS55**	**230**
54LS670	Raytheon	54LS670	
54LS73	**Raytheon**	**54LS73**	**232**
54LS74	**Raytheon**	**54LS74**	**235**
54LS83	**Raytheon**	**54LS83A**	**239**
54LS86	**Raytheon**	**54LS86**	**242**
54LS90	**Raytheon**	**54LS90**	**243**
54LS92	**Raytheon**	**54LS92**	**243**
54LS93	**Raytheon**	**54LS93**	**243**
54LS95	Raytheon	54LS95B	
5400	Motorola	MC5400	
	Raytheon	5400	
	Signetics	5400	
	TI	SN5400	
5401	Motorola	MC5401	
	Raytheon	5401	
5401	Signetics	5401	
	TI	SN5401	
5402	Signetics	5402	
	TI	SN5402	
5403	Motorola	MC5403	
	Raytheon	5403	
	Signetics	5403	
	TI	SN5403	
5404	Motorola	MC5404	
	Raytheon	5404	
	TI	SN5404	
5405	Motorola	MC5405	
	Raytheon	5405	
	Signetics	5405	
	TI	SN5405	
5406	Motorola	MC5406	
	TI	SN5406	
5407	Motorola	MC5407	
	TI	SN5407	
5408	Motorola	MC5408	
	Raytheon	5408	
	Signetics	5408	
	TI	SN5408	
5409	Motorola	MC5409	
	Raytheon	5409	
	TI	SN5409	
5410	Motorola	MC5410	
	Raytheon	5410	
	Signetics	5410	
	TI	SN5410	
54107	AMD	SN54107	
	Motorola	MC54107	
	TI	SN54107	
5411	Raytheon	5411	
	Signetics	5411	
5412	Motorola	MC5412	
	Raytheon	5412	
	TI	SN5412	
54121	Motorola	MC9603	
	TI	SN54121	
54123	Raytheon	54123	
	TI	SN54123	
54136	Raytheon	54136	
	TI	SN54136	
54145	Motorola	MC93145	
	Raytheon	54145	
	TI	SN54145	
5415	Raytheon	5415	
54150	Motorola	MC93150	
	Raytheon	54150	
	TI	SN54150	
54151	Motorola	MC93151	
	Raytheon	54151	
	TI	SN54151A	
54152	Motorola	MC93152	
	Raytheon	54152	
	TI	SN54152A	
54153	AMD	SN54153	
	Motorola	MC93153	
	Raytheon	54153	
	TI	SN54153	
54154	AMD	SN54154	
	Motorola	MC9311	
	Raytheon	54154	
	TI	SN54154	
54155	Raytheon	54155	
	TI	SN54155	
54156	Raytheon	54156	
	TI	SN54156	
54157	Motorola	MC9322	
	Raytheon	54157	
54158	Raytheon	54158	
54159	Raytheon	54159	
	TI	SN54159	
5416	Motorola	MC5416	
	TI	SN5416	
54160	AMD	SN54160	
	Motorola	MC9310	
	Raytheon	54160	
	TI	SN54160	
54161	AMD	SN54161	
54161	Motorola	MC9316	
	Raytheon	54161	
	TI	SN54161	
54162	Raytheon	54162	
	TI	SN54162	
54163	Raytheon	54163	
	TI	SN54163	
54164	AMD	SN54164	
	Motorola	MC93164	
	Raytheon	54164	
	TI	SN54164	
54166	Raytheon	54166	
	TI	SN54166	
5417	Motorola	MC9417	
	TI	SN5417	
54170	Raytheon	54170	
	TI	SN54170	
54174	Raytheon	54174	
	TI	SN54174	
54175	Raytheon	54175	
	TI	SN54175	
54176	Motorola	MC93176	
	TI	SN54176	
54177	Motorola	MC93177	
	TI	SN54177	
54178	Motorola	MC93178	
	TI	SN54178	
54179	Motorola	MC93179	
	TI	SN54179	
54180	Motorola	MC93180	
	Raytheon	54180	
	TI	SN54180	
54181	AMD	SN54181	
	Motorola	MC9341	
	Raytheon	54181	
	TI	SN54181	
54182	AMD	SN54182	
	Motorola	MC9342	
	Raytheon	54182	
	TI	SN54182	
54190	Raytheon	54190	
	TI	SN54190	
54191	Raytheon	54191	
	TI	SN54191	
54192	AMD	SN54192	
	Motorola	MC9360	
	Raytheon	54192	
	Signetics	54192	
	TI	SN54192	
54193	AMD	SN54193	
	Motorola	MC9366	
	Raytheon	54193	
	Signetics	54193	
	TI	SN54193	
54194	Raytheon	54194	
	TI	SN54194	
54195	Raytheon	54195	
	TI	SN54195	
54198	Raytheon	54198	
	TI	SN54198	
54199	Raytheon	54199	
	TI	SN54199	
5420	Motorola	MC5420	
	Signetics	5420	
	TI	SN5420	
5421	Raytheon	5421	
5422	Raytheon	5422	
5423	Motorola	MC5423	
	TI	SN5423	
5425	Motorola	MC5425	
	TI	SN5425	
5426	Motorola	MC5426	
	TI	SN5426	
5427	Motorola	MC5427	
	TI	SN5427	
54283	Raytheon	54283	
	TI	SN54283	
5430	Motorola	MC5430	
	Signetics	5430	
	TI	SN5430	
5437	Motorola	MC5437	
5437	TI	SN5437	
5438	Motorola	MC5438	
	TI	SN5438	
5440	Motorola	MC5440	
	Signetics	5440	
	TI	SN5440	
5442	Motorola	MC9352	
	Raytheon	5442	
	Signetics	5442	
	TI	SN5442	
5443	Motorola	MC9353	
	Raytheon	5443	
	Signetics	5443	
	TI	SN5443	
5444	Motorola	MC9354	
	Raytheon	5444	
	Signetics	5444	
	TI	SN5444A	
5445	Motorola	MC9345	
	Raytheon	5445	
	TI	SN5445A	
5446	Motorola	MC9357A	
	TI	SN5446A	
5447	Motorola	MC9357B	
	TI	SN5447A	
5448	Motorola	MC9358	
	Signetics	5448	
	TI	SN5448	
5449	Motorola	MC9359	
	TI	SN5449	
5450	Motorola	MC5450	
	Signetics	5450	
	TI	SN5450	
5451	Motorola	MC5451	
	Signetics	5451	
	TI	SN5451	
5453	Motorola	MC5453	
	Signetics	5453	
	TI	SN5453	
5454	Motorola	MC5454	
	Signetics	5454	
	TI	SN5454	
5460	Motorola	MC5460	
	Signetics	5460	
	TI	SN5460	
5470	Motorola	MC5470	
	Signetics	5470	
	TI	SN5470	
5472	Motorola	MC5472	
	Signetics	5472	
	TI	SN5472	
5473	Motorola	MC5473	
	Signetics	5473	
	TI	SN5473	
5474	Motorola	MC5474	
	Raytheon	5474	
	Signetics	5474	
	TI	SN5474	
5475	Motorola	MC9375	
	Signetics	5475	
	TI	SN5475	
5476	Motorola	MC5476	
	Signetics	5476	
	TI	SN5476	
5477	Motorola	MC9377	
	TI	SN5477	
5480	Motorola	MC9380	
	Signetics	5480	
	TI	SN5480	
5481	Motorola	MC4304	
	Raytheon	5481	
	TI	SN5481A	
5482	Motorola	MC9382	
	TI	SN5482	
5483	Motorola	MC9383	
	Raytheon	5483	
	Signetics	5483A	
	TI	SN5483A	
5486	Raytheon	5486	
	Signetics	5486	
	TI	SN5486	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Fairchild Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
5488	Motorola	MCM4002	
	TI	SN5488A	
5489	AMD	SN5489	
	Motorola	MC4064	
5490	Motorola	MC9390	
	Signetics	5490	
	TI	SN5490A	
5491	Motorola	MC9391	
	Signetics	5491	
	TI	SN5491A	
5492	Motorola	MC9392	
	Signetics	5492	
	TI	SN5492A	
5493	Motorola	MC9393	
	Signetics	5493	
	TI	SN5493A	
5494	Motorola	MC9394	
	Signetics	5494	
	TI	SN5494A	
5495	Motorola	MC9395	
	Signetics	5495	
	TI	SN5495A	
5496	Motorola	MC9396	
	Signetics	5496	
	TI	SN5496	
55107	AMD	SN55107B	
	National	**DS55107**	**475**
	Raytheon	RM55107	
	TI	SN55107	
55108	AMD	SN55108	
	National	**DS55108**	**475**
	Raytheon	RM55108	
	TI	SN55108	
55109	AMD	SN55109	
	Raytheon	RM55109	
	TI	SN55109	
55110	Raytheon	RM55110	
	TI	SN55110	
55235	Motorola	MC55325	
5524	National	DS5524	
	TI	SN5524	
6105	SSS	SCL5430	
74H00	Motorola	MC74H00	
	Raytheon	74H00	
	Signetics	74H00	
	TI	SN74H00	
74H01	Motorola	MC74H01	
	Raytheon	74H01	
	Signetics	74H01	
	TI	SN74H01	
74H04	Motorola	MC74H04	
	Raytheon	74H04	
	Signetics	74H04	
	TI	SN74H04	
74H05	Motorola	MC74H05	
	Raytheon	74H05	
	Signetics	74H05	
	TI	SN74H05	
74H08	Motorola	MC74H08	
74H10	Motorola	MC74H10	
	Raytheon	74H10	
	Signetics	74H10	
	TI	SN74H10	
74H101	Motorola	MC74H101	
	TI	SN74H101	
74H102	Motorola	MC74H102	
	TI	SN74H102	
74H105	Motorola	MC9001	
74H108	Motorola	MC74H108	
	TI	SN74H108	
74H11	Motorola	MC74H11	
	Raytheon	74H11	
	TI	SN74H11	
74H20	Motorola	MC74H20	
	Raytheon	74H20	
	Signetics	74H20	
	TI	SN74H20	
74H21	Motorola	MC74H21	
	TI	SN74H21	
74H22	Motorola	MC74H22	
	Raytheon	74H22	
	TI	SN74H22	
74H30	Motorola	MC74H30	
	Signetics	74H30	
	TI	SN74H30	
74H40	Motorola	MC74H40	
	Raytheon	74H40	
	Signetics	74H40	
	TI	SN74H40	
74H50	Motorola	MC74H50	
	TI	SN74H50	
74H51	Motorola	MC74H51	
	TI	SN74H51	
74H52	Motorola	MC74H52	
	TI	SN74H52	
74H53	Motorola	MC74H53	
	TI	SN74H53	
74H54	Motorola	MC74H54	
	TI	SN74H54	
74H55	Motorola	MC74H55	
	TI	SN74H55	
74H60	Motorola	MC74H60	
	TI	SN74H60	
74H61	Motorola	MC74H61	
	TI	SN74H61	
74H62	Motorola	MC74H62	
	TI	SN74H62	
74H71	Motorola	MC74H71	
	TI	SN74H71	
74H72	Motorola	MC74H72	
	TI	SN74H72	
74H73	Motorola	MC74H73	
	Signetics	74H73	
	TI	SN74H73	
74H74	Motorola	MC74H74	
	Raytheon	74H74	
	TI	SN74H74	
74H76	Signetics	74H76	
	TI	SN74H76	
74LS00	**Raytheon**	**74LS00**	**210**
74LS02	**Raytheon**	**74LS02**	**214**
74LS03	**Raytheon**	**74LS03**	**212**
74LS05	**Raytheon**	**74LS05**	**212**
74LS08	**Raytheon**	**74LS08**	**215**
74LS09	**Raytheon**	**74LS09**	**217**
74LS10	**Raytheon**	**74LS10**	**210**
74LS109	**Raytheon**	**74LS109**	**251**
74LS11	**Raytheon**	**74LS11**	**215**
74LS112	**Raytheon**	**74LS112**	**232**
74LS113	**Raytheon**	**74LS113**	**232**
74LS114	**Raytheon**	**74LS114**	**237**
74LS138	**Raytheon**	**74LS138**	**254**
74LS139	**Raytheon**	**74LS139**	**254**
74LS14	**Raytheon**	**74LS14**	**218**
74LS15	**Raytheon**	**74LS15**	**217**
74LS151	**Raytheon**	**74LS151**	**256**
74LS152	**Raytheon**	**74LS152**	**256**
74LS153	**Raytheon**	**74LS153**	**258**
74LS155	**Raytheon**	**74LS155**	**260**
74LS156	**Raytheon**	**74LS156**	**260**
74LS157	**Raytheon**	**74LS157**	**262**
74LS158	**Raytheon**	**74LS158**	**262**
74LS160	**Raytheon**	**74LS160**	**264**
74LS161	**Raytheon**	**74LS161**	**264**
74LS162	**Raytheon**	**74LS162**	**264**
74LS163	**Raytheon**	**74LS163**	**264**
74LS164	**Raytheon**	**74LS164**	**271**
74LS170	Raytheon	74LS170	
74LS174	**Raytheon**	**74LS174**	**275**
74LS175	**Raytheon**	**74LS175**	**275**
74LS181	**Raytheon**	**74LS181**	**277**
74LS190	**Raytheon**	**74LS190**	**283**
74LS191	**Raytheon**	**74LS191**	**283**
74LS192	**Raytheon**	**74LS192**	**291**
74LS193	**Raytheon**	**74LS193**	**291**
74LS194A	**Raytheon**	**74LS194A**	**299**
74LS195A	**Raytheon**	**74LS195A**	**302**
74LS196	**Raytheon**	**74LS196**	**305**
74LS197	**Raytheon**	**74LS197**	**305**
74LS20	**Raytheon**	**74LS20**	**210**
74LS21	**Raytheon**	**74LS21**	**215**
74LS22	**Raytheon**	**74LS22**	**212**
74LS251	**Raytheon**	**74LS251**	**309**
74LS253	**Raytheon**	**74LS253**	**312**
74LS255	**Raytheon**	**74LS255**	**313**
74LS257	**Raytheon**	**74LS257**	**315**
74LS258	**Raytheon**	**74LS258**	**315**
74LS26	**Raytheon**	**74LS26**	**222**
74LS266	**Raytheon**	**74LS266**	**253**
74LS27	**Raytheon**	**74LS27**	**214**
74LS279	Raytheon	74LS279	
74LS283	Raytheon	74LS283	
74LS295	**Raytheon**	**74LS295A**	**321**
74LS298	**Raytheon**	**74LS298**	**323**
74LS30	**Raytheon**	**74LS30**	**210**
74LS32	**Raytheon**	**74LS32**	**225**
74LS365	**Raytheon**	**74LS365**	**325**
74LS366	**Raytheon**	**74LS366**	**325**
74LS367	Raytheon	74LS367	
74LS368	Raytheon	74LS368	
74LS37	**Raytheon**	**74LS37**	**223**
74LS38	**Raytheon**	**74LS38**	**226**
74LS40	**Raytheon**	**74LS40**	**223**
74LS42	**Raytheon**	**74LS42**	**227**
74LS51	**Raytheon**	**74LS51**	**230**
74LS54	**Raytheon**	**74LS54**	**230**
74LS55	**Raytheon**	**74LS55**	**230**
74LS670	Raytheon	74LS670	
74LS73	**Raytheon**	**74LS73**	**232**
74LS74	**Raytheon**	**74LS74**	**235**
74LS83	**Raytheon**	**74LS83A**	**239**
74LS86	**Raytheon**	**74LS86**	**242**
74LS90	**Raytheon**	**74LS90**	**243**
74LS92	**Raytheon**	**74LS92**	**243**
74LS93	**Raytheon**	**74LS93**	**243**
74LS95	Raytheon	74LS95B	♦
74S158	AMD	SN74S158	
	TI	SN74S158	
74S175	AMD	SN74S175	
	TI	SN74S175	
74S194	AMD	SN74S194	
	TI	SN74S194	
74S258	AMD	SN74S258	
	TI	SN74S258	
7400	Hitachi	HD2503	
	Motorola	MC7400	
	Raytheon	7400	
	Signetics	7400	
	TI	SN7400	
7401	Hitachi	HD2509	
	Motorola	MC7401	
	Raytheon	7401	
	Signetics	7401	
	TI	SN7401	
7402	Hitachi	HD2511	
	Motorola	MC7402	
	Signetics	7402	
	TI	SN7402	
7403	Hitachi	HD2528	
	Motorola	MC7403	
	Raytheon	7403	
	Signetics	7403	
	TI	SN7403	
7404	Hitachi	HD2522	
	Motorola	MC7404	
	Raytheon	7404	
	Signetics	7404	
	TI	SN7404	
7405	Hitachi	HD2523	
	Motorola	MC7405	
	Raytheon	7405	
	Signetics	7405	
	TI	SN7405	
7406	Motorola	MC7406	
	TI	SN7406	
7407	Motorola	MC7407	
	TI	SN7407	
7408	Hitachi	HD2550	
	Motorola	MC7408	
7408	Raytheon	7408	
	Signetics	7408	
	TI	SN7408	
7409	Motorola	MC7409	
	Raytheon	7409	
	TI	SN7409	
7410	Hitachi	HD2551	
	Motorola	MC7410	
	Raytheon	7410	
	Signetics	7410	
	TI	SN7410	
74107	AMD	SN74107	
	Hitachi	HD2530	
	Motorola	MC74H107	
	TI	SN74107	
7411	Raytheon	7411	
	Signetics	7411	
7412	Raytheon	7412	
	TI	SN7412	
74121	Motorola	MC8603	
	TI	SN74121	
74123	Raytheon	74123	
	TI	SN74123	
74136	Raytheon	74136	
	TI	SN74136	
74141	Signetics	74141	
	TI	SN74141	
74145	Motorola	MC83145	
	Raytheon	74145	
	TI	SN74145	
7415	Raytheon	7415	
74150	Motorola	MC83150	
	Raytheon	74150	
	TI	SN74150	
74151	Motorola	MC83151	
	Raytheon	74151	
	TI	SN74151A	
74152	Motorola	MC83152	
	Raytheon	74152	
	TI	SN74152	
74153	AMD	SN74153	
	Motorola	MC83153	
	Raytheon	74153	
	TI	SN74153	
74154	AMD	SN74154	
	Motorola	MC8311	
	Raytheon	74154	
	TI	SN74154	
74155	Raytheon	74155	
	TI	SN74155	
74156	Raytheon	74156	
74157	AMD	SN74157	
	Motorola	MC8322	
	Raytheon	74157	
	TI	SN74157	
74158	Raytheon	74158	
74159	Raytheon	74159	
	TI	SN74159	
7416	Motorola	MC7416	
	TI	SN7416	
74160	AMD	SN74160	
	Motorola	MC8310	
		MC8316	
	Raytheon	74160	
	TI	SN74160	
74161	Raytheon	74161	
	TI	SN74161	
74162	Raytheon	74162	
	TI	SN74162	
74163	Raytheon	74163	
	TI	SN74163	
74164	AMD	SN74164	
	Motorola	MC83164	
	Raytheon	74164	
	TI	SN74164	
74165	Motorola	MC83165	
	Raytheon	74165	
	TI	SN74165	
74166	Raytheon	74166	
	TI	SN74166	
7417	Motorola	MC7417	

♦ Discontinued

Bold face device numbers indicate manufacturers' data is provided in the IC Master on the pages noted.

Fairchild Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
7417	TI	SN7417	
74170	Raytheon	74170	
	TI	SN74170	
74174	AMD	SN74174	
	Raytheon	74174	
	TI	SN74174	
74175	AMD	SN74175	
	Raytheon	74175	
	TI	SN74175	
74176	Motorola	MC83176	
	TI	SN74176	
74177	Motorola	MC83177	
	TI	SN74177	
74178	Motorola	MC83178	
	TI	SN74178	
74179	Motorola	MC83179	
	TI	SN74179	
74180	Motorola	MC83180	
	Raytheon	74180	
	TI	SN74180	
74181	AMD	SN74181	
	Motorola	MC8341	
	Raytheon	74181	
	TI	SN74181	
74182	AMD	SN74182	
	Motorola	MC8342	
	Raytheon	74182	
	TI	SN74182	
74190	Raytheon	74190	
	TI	SN74190	
74191	Raytheon	74191	
	TI	SN74191	
74192	AMD	SN74192	
	Motorola	MC8360	
	Raytheon	74192	
	Signetics	74192	
	TI	SN74192	
74193	AMD	SN74193	
	Motorola	MC8366	
	Raytheon	74193	
	Signetics	74193	
	TI	SN74193	
74194	Raytheon	74194	
	TI	SN74194	
74195	Raytheon	74195	
	Signetics	7447	
	TI	SN74195	
		SN7447A	
74198	Raytheon	74198	
	TI	SN74198	
74199	Raytheon	74199	
	TI	SN74199	
7420	Hitachi	HD2504	
	Motorola	MC7420	
	Raytheon	7420	
	Signetics	7420	
	TI	SN7420	
7421	Raytheon	7421	
7422	Raytheon	7422	
	TI	SN7422	
7423	Motorola	MC7423	
	TI	SN7423	
7425	Motorola	MC7425	
	TI	SN7425	
7426	Motorola	MC7426	
	TI	SN7426	
7427	Motorola	MC7427	
	TI	SN7427	
74283	Raytheon	74283	
	TI	SN74283	
7430	Hitachi	HD2508	
	Motorola	MC7430	
	Signetics	7430	
	TI	SN7430	
7437	Motorola	MC7437	
	TI	SN7437	
7438	Motorola	MC7438	
7438	TI	SN7438	
7440	Hitachi	HD2501	
	Motorola	MC7440	
	Signetics	7440	
	TI	SN7440	
7441	Motorola	MC8315	
	Signetics	7441	
	TI	SN74141	
7442	Motorola	MC8352	
	Raytheon	7442	
	Signetics	7442	
	TI	SN7442A	
7443	Motorola	MC8353	
	Raytheon	7443	
	Signetics	7443	
	TI	SN7443A	
7444	Motorola	MC8354	
	Raytheon	7444	
	Signetics	7444	
	TI	SN7444A	
7445	Motorola	MC8345	
	Raytheon	7445	
	TI	SN7445	
7446	Motorola	MC8357	
	TI	SN7446A	
7447	Motorola	MC8357	
7448	Motorola	MC8358	
	Signetics	7448	
	TI	SN7448	
7449	Motorola	MC8359	
7450	Hitachi	HD2506	
	Motorola	MC7450	
	Signetics	7450	
	TI	SN7450	
7451	Hitachi	HD2505	
	Motorola	MC7451	
	Signetics	7451	
	TI	SN7451	
7453	Hitachi	HD2512	
	Motorola	MC7453	
	Signetics	7453	
	TI	SN7453	
7454	Hitachi	HD2514	
	Motorola	MC7454	
	Signetics	7454	
	TI	SN7454	
7460	Hitachi	HD2502	
	Motorola	MC7460	
	Signetics	7460	
	TI	SN7460	
7470	Hitachi	HD2539	
	Motorola	MC7470	
	Signetics	7470	
	TI	SN7470	
7472	Hitachi	HD2529	
	Motorola	MC7472	
	Signetics	7472	
	TI	SN7472	
7473	Hitachi	HD2515	
	Motorola	MC7473	
	Signetics	7473	
	TI	SN7473	
7474	Hitachi	HD2510	
	Motorola	MC7474	
	Raytheon	7474	
	Signetics	7474	
	TI	SN7474	
7475	Motorola	MC8375	
	Signetics	7475	
	TI	SN7475	
7476	Hitachi	HD2516	
	Motorola	MC7476	
	Signetics	7476	
	TI	SN7476	
7477	Motorola	MC8377	
7480	Signetics	7480	
	TI	SN7480	
7481	Motorola	MC4004	
	Raytheon	7481	
	TI	SN7481A	
7482	Hitachi	HD2513	
7482	Motorola	MC8382	
	TI	SN7482	
7483	Motorola	MC8383	
	Raytheon	7483	
	Signetics	7483	
	TI	SN7483A	
7486	Hitachi	HD2526	
	Raytheon	7486	
	Signetics	7486	
	TI	SN7486	
7488	Motorola	MC4002	
	TI	SN7488A	
7489	AMD	SN7489	
	Motorola	MC4064	
	TI	SN7489	
7490	Hitachi	HD2519	
	Motorola	MC8390	
	Signetics	7490	
	TI	SN7490A	
7491	Hitachi	HD2524	
	Motorola	MC8391	
	Signetics	7491	
	TI	SN7491A	
7492	Hitachi	HD2521	
	Motorola	MC8392	
	Signetics	7492	
	TI	SN7492A	
7493	Hitachi	HD2520	
	Motorola	MC8393	
	Signetics	7493	
	TI	SN7493A	
7494	Motorola	MC8394	
	Signetics	7494	
	TI	SN7494	
7495	Hitachi	HD2534	
	Motorola	MC8395	
	Signetics	7495	
	TI	SN7495A	
7496	Motorola	MC8396	
	Signetics	7496	
	TI	SN7496	
75107	ITT	ITT75107	
	National	**DS75107**	**475**
	Raytheon	RC75107	
	TI	SN74107	
75108	ITT	ITT75108	
	National	**DS75108**	**475**
	Raytheon	RC75108	
	TI	SN75108	
75109	ITT	ITT75109	
	Raytheon	RC75109	
	TI	SN75109	
75110	ITT	ITT75110	
	Raytheon	RC75110	
	TI	SN75110	
75234	ITT	ITT75234	
75235	ITT	ITT75235	
7524	ITT	ITT7524	
	Motorola	MC7524	
	National	DS7524	
	Signetics	7524	
	TI	SN7524	
7525	ITT	ITT7525	
	Motorola	MC7525	
	National	DS7525	
	Signetics	7525	
	TI	SN7525	
75325	Motorola	MC75325	
	National	**DS75325**	**495**
	Signetics	75325	
	TI	SN75325	
75450	ITT	ITT75450	
	National	DS75450	
	Signetics	75450	
	Silicon G	SG75450	
	TI	SN75450	
75451	ITT	ITT75451	
	National	DS75451	
	Signetics	75451	
	TI	SN75451	
75452	ITT	ITT75452	
75452	National	DS75452	
	Signetics	75452	
	TI	SN75452	
75453	National	DS75453	
	Signetics	75453	
	TI	SN75453	
75454	ITT	ITT75454	
	National	DS75454	
	Signetics	75454	
	TI	SN75454	
75460	ITT	ITT75460	
	National	DS75460	
	Silicon G	SG75460	
	TI	SN75460	
75461	ITT	ITT75461	
	National	DS75461	
	TI	SN75461	
75462	ITT	ITT75462	
	National	DS75462	
	TI	SN75462	
75463	National	DS75463	
	TI	SN75463	
75464	ITT	ITT75464	
	National	DS75464	
	TI	SN75464	
75491	National	DS75491	
	TI	SN75491	
75492	National	DS75492	
	TI	SN75492	
8T13	National	DS55121	
	TI	SN55121	
8T14	National	DS55122	
	TI	SN55122	
8T23	National	DS75123	
	TI	SN75123	
8T24	National	DS75124	
	TI	SN75124	
9H00	Motorola	MC54H00	
		MC74H00	
	National	DM54H00	
		DM74H00	
	Signetics	54H00	
		74H00	
	TI	SN54H00	
		SN74H00	
9H01	Motorola	MC54H01	
		MC74H01	
	National	DM54H01	
9H04	Motorola	MC54H04	
		MC74H04	
	National	DM54H04	
		DM74H04	
	Signetics	54H04	
		74H04	
	TI	SN54H04	
		SN74H04	
9H05	Motorola	MC54H05	
		MC74H05	
	National	DM54H05	
		DM74H05	
	Signetics	54H05	
		74H05	
	TI	SN54H05	
		SN74H05	
9H08	Motorola	MC54H08	
		MC74H08	
	National	DM54H08	
		DM74H08	
	Signetics	54H08	
		74H08	
9H10	Motorola	MC54H10	
		MC74H10	
	National	DM54H10	
		DM74H10	
	Signetics	54H10	
		74H10	
9H101	Motorola	MC54H101	
		MC74H101	
	Signetics	54H101	
		74H101	
	TI	SN54H101	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

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Manufacturer Device	Replacement Source	Device	IC Master Page
9H101	TI	SN74H101	
9H102	Motorola	MC54H102	
		MC74H102	
	Signetics	54H102	
		74H102	
9H103	National	DM54H103	
		DM74H103	
	TI	SN54H103	
		SN74H103	
9H106	National	DM54H106	
		DM74H106	
	Signetics	54H106	
		74H106	
	TI	SN54H106	
		SN74H106	
9H108	Motorola	MC54H108	
		MC74H108	
	National	DM54H108	
		DM74H108	
	Signetics	54H108	
		74H108	
	TI	SN54H108	
		SN74H108	
9H11	Motorola	MC54H11	
		MC74H11	
	National	DM54H11	
		DM74H11	
	Signetics	54H11	
		74H11	
	TI	SN54H11	
		SN74H11	
9H20	Motorola	MC54H20	
		MC74H20	
	National	DM54H20	
		DM74H20	
	Signetics	54H20	
		74H20	
	TI	SN54H20	
		SN74H20	
9H21	Motorola	MC54H21	
		MC74H21	
	National	DM54H21	
		DM74H21	
	TI	SN54H21	
		SN74H21	
9H22	Motorola	MC54H22	
		MC74H22	
	National	DM54H22	
		DM74H22	
	Signetics	54H22	
		74H22	
	TI	SN54H22	
		SN74H22	
9H30	Motorola	MC54H30	
		MC74H30	
	National	DM54H30	
		DM74H30	
	Signetics	54H30	
		74H30	
	TI	SN54H30	
		SN74H30	
9H40	Motorola	MC54H40	
		MC74H40	
	National	DM54H40	
		DM74H40	
	Signetics	54H40	
		74H40	
	TI	SN54H40	
		SN74H40	
9H50	Motorola	MC74H50	
	National	DM54H50	
		DM74H50	
	Signetics	54H50	
		74H50	
	TI	SN54H50	
		SN74H50	
9H51	Motorola	MC54H51	
9H51	Motorola	MC74H51	
	National	DM54H51	
		DM74H51	
	Signetics	54H51	
		74H51	
	TI	SN54H51	
		SN74H51	
9H52	Motorola	MC54H52	
		MC74H52	
	National	DM54H52	
		DM74H52	
	TI	SN54H52	
		SN74H52	
9H53	Motorola	MC54H53	
		MC74H53	
	National	DM54H53	
		DM74H53	
	TI	SN54H53	
		SN74H53	
9H54	Motorola	MC54H54	
		MC74H54	
	National	DM54H54	
		DM74H54	
	TI	SN54H54	
		SN74H54	
9H55	Motorola	MC54H55	
		MC74H55	
	National	DM54H55	
		DM74H55	
	TI	SN54H55	
		SN74H55	
9H60	Motorola	MC54H60	
		MC74H60	
	National	DM54H60	
		DM74H60	
	TI	SN54H60	
		SN74H60	
9H61	Motorola	MC54H61	
		MC74H61	
	National	DM54H61	
		DM74H61	
	Signetics	54H61	
		74H61	
	TI	SN54H61	
		SN74H61	
9H62	Motorola	MC54H62	
		MC74H62	
	National	DM54H62	
		DM74H62	
	Signetics	54H62	
		74H62	
	TI	SN54H62	
		SN74H62	
9H71	Motorola	MC54H71	
		MC74H71	
	National	DM54H71	
		DM74H71	
	Signetics	54H71	
		74H71	
	TI	SN54H71	
		SN74H71	
9H72	Motorola	MC54H72	
	National	DM54H72	
		DM74H72	
	Signetics	54H72	
		74H72	
	TI	SN54H72	
		SN74H72	
9H73	Motorola	MC54H73	
	National	DM54H73	
		DM74H73	
	Signetics	54H73	
		74H73	
9H74	Motorola	MC54H74	
		MC74H74	
	National	DM54H74	
		DM74H74	
	Signetics	54H74	
		74H74	
	TI	SN54H74	
		SN74H74	
9H76	National	DM54H76	
		DM74H76	
	Signetics	54H76	
		74H76	
	TI	SN54H76	
		SN74H76	
9H78	National	DM54H78	
		DM74H78	
	TI	SN54H78	
		SN74H78	
9LS00	National	DM54LS00	
		DM74LS00	
	Raytheon	**9LS00**	**210**
9LS02	National	DM54LS02	
		DM74LS02	
	Raytheon	**9LS02**	**214**
9LS03	National	DM54LS03	
		DM74LS03	
	Raytheon	**9LS03**	**212**
9LS04	National	DM54LS04	
		DM74LS04	
	Raytheon	**9LS04**	**210**
9LS05	National	DM54LS05	
		DM74LS05	
	Raytheon	**9LS05**	**212**
9LS08	National	DM54LS08	
		DM74LS08	
	Raytheon	**9LS08**	**215**
9LS09	National	DM54LS09	
		DM74LS09	
9LS10	National	DM54LS10	
		DM74LS10	
	Raytheon	**9LS10**	**210**
9LS109	National	DM54LS109	
		DM74LS109	
	Raytheon	**9LS109**	**251**
9LS11	National	DM54LS11	
		DM74LS11	
	Raytheon	**9LS11**	**215**
9LS112	National	DM54LS112	
		DM74LS112	
	Raytheon	**9LS112**	**232**
9LS113	National	DM54LS113	
		DM74LS113	
	Raytheon	**9LS113**	**232**
9LS114	National	DM54LS114	
		DM74LS114	
	Raytheon	**9LS114**	**237**
9LS125	National	DM54LS125	
		DM74LS125	
9LS126	National	DM54LS126	
		DM74LS126	
9LS132	National	DM54LS132	
		DM74LS132	
9LS133	National	DM74S133	
9LS136	National	DM54LS136	
		DM74LS136	
	Raytheon	**9LS136**	**253**
9LS138	National	DM54LS138	
		DM74LS138	
	Raytheon	**9LS138**	**254**
9LS139	National	DM54LS139	
		DM74LS139	
	Raytheon	**9LS139**	**254**
9LS14	National	DM54LS14	
		DM74LS14	
	Raytheon	**9LS14**	**218**
9LS15	National	DM54LS15	
		DM74LS15	
	Raytheon	**9LS15**	**217**
9LS151	National	DM54LS151	
		DM74LS151	
	Raytheon	**9LS151**	**256**
9LS152	**Raytheon**	**9LS152**	**256**
9LS153	National	DM54LS153	
		DM74LS153	
	Raytheon	**9LS153**	**258**
9LS155	National	DM54LS155	
		DM74LS155	
	Raytheon	**9LS155**	**260**
9LS156	National	DM54LS156	
9LS156	National	DM74LS156	
	Raytheon	**9LS156**	**260**
9LS157	National	DM54LS157	
		DM74LS157	
	Raytheon	**9LS157**	**262**
9LS158	National	DM54LS158	
		DM74LS158	
	Raytheon	**9LS158**	**262**
9LS160	National	DM54LS160	
		DM74LS160	
	Raytheon	**9LS160**	**264**
9LS161	National	DM54LS161	
		DM74LS161	
	Raytheon	**9LS161**	**264**
9LS162	National	DM54LS162	
		DM74LS162	
	Raytheon	**9LS162**	**264**
9LS163	National	DM54LS163	
		DM74LS163	
	Raytheon	**9LS163**	**264**
9LS164	National	DM54LS164	
		DM74LS164	
9LS170	National	DM54LS170	
		DM74LS170	
	Raytheon	9LS170	
9LS174	National	DM54LS174	
		DM74LS174	
	Raytheon	**9LS174**	**275**
9LS175	National	DM54LS175	
		DM74LS175	
	Raytheon	**9LS175**	**275**
9LS181	National	DM54181	
		DM74181	
	Raytheon	**9LS181**	**277**
9LS190	National	DM54LS190	
		DM74LS190	
	Raytheon	**9LS190**	**283**
9LS191	National	DM54LS191	
		DM74LS191	
	Raytheon	**9LS191**	**283**
9LS192	National	DM54LS192	
		DM74LS192	
	Raytheon	**9LS192**	**291**
9LS193	National	DM54LS193	
		DM74LS193	
	Raytheon	**9LS193**	**291**
9LS194	National	DM54LS194	
		DM74LS194	
	Raytheon	**9LS194A**	**299**
9LS195	National	DM54LS195	
		DM74LS195	
	Raytheon	**9LS195A**	**302**
9LS196	National	DM54LS196	
		DM74LS196	
	Raytheon	**9LS196**	**305**
9LS197	National	DM54LS197	
		DM74LS197	
9LS20	National	DM54LS20	
		DM74LS20	
	Raytheon	**9LS20**	**210**
9LS21	National	DM54LS21	
		DM74LS21	
	Raytheon	**9LS21**	**215**
9LS22	National	DM54LS22	
		DM74LS22	
	Raytheon	**9LS22**	**212**
9LS251	National	DM54LS251	
		DM74LS251	
	Raytheon	**9LS251**	**309**
9LS253	National	DM54LS253	
		DM74LS253	
	Raytheon	**9LS253**	**312**
9LS257	National	DM54LS257	
		DM74LS257	
	Raytheon	**9LS257**	**315**
9LS258	National	DM54LS258	
		DM74LS258	
	Raytheon	**9LS258**	**315**
9LS259	National	DM8334	
		DM9334	
9LS266	National	DM54LS266	

♦ Discontinued

Bold face device numbers indicate manufacturers' data is provided in the IC Master on the pages noted.

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Manufacturer Device	Replacement Source	Device	IC Master Page
9LS266	National	DM74LS266	
	Raytheon	**9LS266**	**253**
9LS27	National	DM54LS27	
		DM74LS27	
	Raytheon	**9LS27**	**214**
9LS279	National	DM54LS279	
		DM74LS279	
9LS283	National	DM54LS283	
		DM74LS283	
	Raytheon	9LS283	
9LS295	National	DM54LS295	
		DM74LS295	
	Raytheon	**9LS295A**	**321**
9LS298	**Raytheon**	**9LS298**	**323**
9LS30	National	DM54LS30	
		DM74LS30	
	Raytheon	**9LS30**	**210**
9LS32	National	DM54LS32	
		DM74LS32	
	Raytheon	**9LS32**	**225**
9LS365	National	DM54LS365	
		DM74LS365	
9LS366	National	DM54LS366	
		DM74LS366	
9LS367	National	DM54LS367	
		DM74LS367	
9LS368	National	DM54LS368	
		DM74LS368	
9LS37	National	DM54LS37	
		DM74LS37	
	Raytheon	**9LS37**	**223**
9LS38	National	DM54LS38	
		DM74LS38	
	Raytheon	**9LS38**	**226**
9LS40	National	DM54LS40	
		DM74LS40	
	Raytheon	**9LS40**	**223**
9LS42	National	DM54LS42	
		DM74LS42	
	Raytheon	**9LS42**	**227**
9LS51	National	DM54LS51	
		DM74LS51	
	Raytheon	**9LS51**	**230**
9LS54	National	DM54LS54	
		DM74LS54	
	Raytheon	**9LS54**	**230**
9LS55	National	DM54LS55	
		DM74LS55	
	Raytheon	**9LS55**	**230**
9LS670	National	DM54LS670	
		DM74LS670	
	Raytheon	9LS670	
9LS73	National	DM54LS73	
		DM74LS73	
9LS74	National	DM54LS74	
		DM74LS74	
	Raytheon	**9LS74**	**235**
9LS83	National	DM54LS83	
		DM74LS83	
	Raytheon	**9LS83A**	**239**
9LS86	National	DM54LS86	
		DM74LS86	
	Raytheon	**9LS86**	**242**
9LS90	**Raytheon**	**9LS90**	**243**
9LS93	**Raytheon**	**9LS93**	**243**
9LS95	Raytheon	9LS95B	
9L00	National	DM54L00	
		DM74L00	
9L04	National	DM54L04	
		DM74L04	
9L24	National	DM8024	
		DM9024	
9L54	National	DM54L54	
		DM74L54	
9L86	National	DM5486	
		DM7486	
9N00	Motorola	MC5400	
9N00	Motorola	MC7400	
	National	DM5400	
		DM7400	
	Signetics	5400	
		7400	
	TI	SN5400	
		SN7400	
9N01	Motorola	MC5401	
		MC7401	
	National	DM5401	
		DM7401	
	Signetics	5401	
		7401	
	TI	SN5401	
		SN7401	
9N02	Motorola	MC7402	
	National	DM5402	
		DM7402	
	Signetics	5402	
		7402	
	TI	SN5402	
		SN7402	
9N03	Motorola	MC5403	
		MC7403	
	National	DM5403	
		DM7403	
	Signetics	5403	
		7403	
	TI	SN5403	
		SN7403	
9N04	Motorola	MC5404	
		MC7404	
	National	DM5404	
		DM7404	
	Signetics	5404	
		7404	
	TI	SN5404	
		SN7404	
9N05	Motorola	MC5405	
		MC7405	
	National	DM5405	
		DM7405	
	Signetics	5405	
		7405	
	TI	SN5405	
		SN7505	
9N06	Motorola	MC5406	
		MC7406	
	National	DM5406	
		DM7406	
	Signetics	5406	
		7406	
	TI	SN5406	
		SN7406	
9N07	Motorola	MC5407	
		MC7407	
	National	DM5407	
		DM7407	
	Signetics	5407	
		7407	
	TI	SN5407	
		SN7407	
9N08	Motorola	MC5408	
		MC7408	
	National	DM5408	
		DM7408	
	Signetics	5408	
		7408	
	TI	SN5408	
		SN7408	
9N09	Motorola	MC5409	
		MC7409	
	National	DM5409	
		DM7409	
	Signetics	7409	
	TI	SN5409	
		SN7409	
9N10	Motorola	MC5410	
		MC7410	
	National	DM5410	
		DM7410	
9N10	Signetics	5410	
	TI	SN5410	
		SN7410	
9N107	Motorola	MC54107	
		MC74H107	
	National	DM54107	
		DM74107	
		DM74107	
	Signetics	54107	
		74107	
	TI	SN54107	
		SN74107	
9N11	National	DM5411	
		DM7411	
	Signetics	5411	
		7411	
9N12	Motorola	MC5412	
	National	DM54LS12	
		DM74LS12	
	TI	SN5412	
		SN7412	
9N122	National	DM54LS122	
		DM74LS122	
		DM74122	
	TI	SN54122	
		SN74122	
9N123	National	DM54123	
		DM74123	
		DM74123	
	TI	SN54123	
		SN74123	
9N13	National	DM5413	
		DM7413	
	TI	SN5413	
		SN7413	
9N132	National	DM54132	
		DM74132	
		DM74132	
	TI	SN54132	
		SN74132	
9N14	National	DM5414	
		DM7414	
	TI	SN5414	
		SN7414	
9N16	Motorola	MC5416	
		MC7416	
	National	DM5416	
		DM7416	
	TI	SN5416	
		SN7416	
9N17	Motorola	MC7417	
		MC9417	
	National	DM5417	
		DM7417	
	TI	SN5417	
		SN7417	
9N20	Motorola	MC5420	
		MC7420	
	National	DM5420	
		DM7420	
	Signetics	5420	
		7420	
	TI	SN5420	
		SN7420	
9N21	National	DM54LS21	
		DM74LS21	
9N23	Motorola	MC5423	
		MC7423	
	National	DM5423	
		DM7423	
	TI	SN5423	
		SN7423	
9N25	Motorola	MC5425	
		MC7425	
	National	DM5425	
		DM7425	
	TI	SN5425	
		SN7425	
9N26	Motorola	MC5426	
		MC7426	
	National	DM5426	
9N26	National	DM7426	
	Signetics	5426	
	TI	SN5426	
		SN7426	
9N27	Motorola	MC5427	
		MC7427	
	National	DM5427	
		DM7427	
	TI	SN5427	
		SN7427	
9N279	National	DM54LS279	
		DM74LS279	
	TI	SN54279	
		SN74279	
9N30	Motorola	MC5430	
		MC7430	
	National	DM5430	
		DM7430	
	Signetics	5430	
		7430	
	TI	SN5430	
		SN7430	
9N32	National	DM5432	
		DM7432	
	TI	SN5432	
		SN7432	
9N37	Motorola	MC5437	
		MC7437	
	National	DM5437	
		DM7437	
	TI	SN5437	
		SN7437	
9N38	Motorola	MC5438	
		MC7438	
	National	DM5438	
		DM7438	
	TI	SN5438	
		SN7438	
9N39	National	DM5401	
		DM7401	
9N40	Motorola	MC5440	
		MC7440	
	National	DM5440	
		DM7440	
	Signetics	5440	
		7440	
	TI	SN5440	
		SN7440	
9N50	Motorola	MC5450	
		MC7450	
	National	DM5450	
		DM7450	
	Signetics	5450	
		7450	
	TI	SN5450	
		SN7450	
9N51	Motorola	MC5451	
		MC7451	
	National	DM5451	
		DM7451	
	Signetics	5451	
		7451	
	TI	SN5451	
		SN7451	
9N53	Motorola	MC5453	
		MC7453	
	National	DM5453	
		DM7453	
	Signetics	5453	
		7453	
	TI	SN5453	
		SN7453	
9N54	Motorola	MC5454	
		MC7454	
	National	DM5454	
		DM7454	
	Signetics	5454	
		7454	
	TI	SN5454	
		SN7454	
9N60	Motorola	MC5460	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Fairchild Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
9N60	Motorola	MC7460	
	National	DM5460	
		DM7460	
	Signetics	5460	
		7460	
	TI	SN5460	
		SN7460	
9N70	Motorola	MC5470	
		MC7470	
	National	DM5470	
		DM7470	
	Signetics	5470	
		7470	
	TI	SN5470	
		SN7470	
9N72	Motorola	MC5472	
		MC7472	
	National	DM5472	
		DM7472	
	Signetics	5472	
		7472	
	TI	SN5472	
		SN7472	
9N73	Motorola	MC5473	
		MC7473	
	National	DM5473	
		DM7473	
	Signetics	5473	
		7473	
	TI	SN5473	
		SN7473	
9N74	Motorola	MC5474	
		MC7474	
	National	DM5474	
		DM7474	
	Raytheon	5474	
	Signetics	5474	
		7474	
	TI	SN5474	
		SN7474	
9N75	Motorola	MC8375	
	TI	SN5475	
		SN7475	
9N76	Motorola	MC5476	
		MC7476	
	National	DM5476	
		DM7476	
	Signetics	5476	
		7476	
	TI	SN5476	
		SN7476	
9N86	National	DM5486	
		DM7486	
	Raytheon	5486	
	Signetics	5486	
		7486	
	TI	SN5486	
		SN7486	
9S00	National	DM74S00	
	Signetics	74S00	
	TI	SN54S00	
		SN74S00	
9S02	National	DM74S02	
	TI	SN54S02	
		SN74S02	
9S03	National	DM74S03	
	Signetics	74S03	
	TI	SN54S03	
		SN74S03	
9S04	National	DM74S04	
	Signetics	74S04	
	TI	SN54S04	
		SN74S04	
9S05	National	DM74S05	
	Signetics	74S05	
	TI	SN54S05	
		SN74S05	
9S08	National	DM74LS08	
	TI	SN54S08	
		SN74S08	
9S09	National	DM74LS09	
	TI	SN54S09	
		SN74S09	
9S10	National	DM74S10	
	TI	SN54S10	
		SN74S10	
9S109	National	DM74LS109	
9S11	National	DM74S11	
	TI	SN54S11	
		SN74S11	
9S112	National	DM74S112	
	TI	SN54S112	
		SN74S112	
9S113	National	DM74S113	
	TI	SN54S113	
		SN74S113	
9S114	National	DM74S114	
	TI	SN54S114	
		SN74S114	
9S132	National	DM54LS132	
		DM74LS132	
	TI	SN54S132	
		SN74S132	
9S133	National	DM74S133	
	TI	SN54S133	
		SN74S133	
9S134	National	DM74S134	
	TI	SN54S134	
		SN74S134	
9S135	National	DM74S135	
	TI	SN54S135	
		SN74S135	
9S140	National	DM74S140	
	TI	SN54S140	
		SN74S140	
9S15	National	DM74S15	
	TI	SN54S15	
		SN74S15	
9S20	National	DM74S20	
	Signetics	74S20	
	TI	SN54S20	
		SN74S20	
9S22	National	DM74S22	
	Signetics	74S22	
	TI	SN54S22	
		SN74S22	
9S30	National	DM74S30	
	TI	SN54S30	
		SN74S30	
9S32	National	DM74S32	
	TI	SN54S32	
		SN74S32	
9S40	National	DM75S40	
	Signetics	74S40	
	TI	SN54S40	
		SN74S40	
9S51	National	DM74S51	
	TI	SN54S51	
		SN74S51	
9S64	National	DM74S64	
	Signetics	74S64	
	TI	SN54S64	
		SN74S64	
9S65	National	DM74S65	
	Signetics	74S65	
	TI	SN54S65	
		SN74S65	
9S74	National	DM74S74	
	TI	SN54S74	
		SN74S74	
9S86	National	DM74S86	
	TI	SN54S86	
		SN74S86	
9001	ITT	ITT9001	
	Motorola	MC3052	
		MC9001	
	TI	SN29001	
9002	ITT	ITT9002	
9002	Motorola	MC7400	
	National	DM9002C	
	TI	SN9002	
9003	ITT	ITT9003	
	Motorola	MC7410	
	National	DM9003C	
	TI	SN29003	
9004	ITT	ITT9004	
	Motorola	MC7420	
	National	DM9004C	
	TI	SN29004	
9005	ITT	ITT9005	
	Motorola	MC7450	
	National	DM9005C	
	TI	SN29005	
9006	ITT	ITT9006	
	Motorola	MC7460	
	National	DM9006C	
9007	ITT	ITT9007	
	TI	SN29007	
9008	ITT	ITT9008	
	National	DM9008C	
	TI	SN29008	
9009	ITT	ITT9009	
	Motorola	MC7440	
	National	DM9009C	
	TI	SN29009	
9012	ITT	ITT9012	
	National	DM9012C	
	TI	SN29012	
9016	ITT	ITT9016	
	Motorola	MC7404	
	National	DM9016C	
	TI	SN29016	
9020	ITT	ITT9020	
9022	ITT	ITT9022	
9024	ITT	ITT9024	
	National	DM74109	
		DM8024	
		DM9024	
	Signetics	74109	
	TI	SN54109	
		SN74109	
9031	Signetics	N8252	
9033	Hitachi	HM2501	
	TI	SN5481A	
		SN7481A	
9034	Motorola	MCM4002	
	Signetics	8224	
	TI	SN5488A	
		SN7488A	
9093	Hitachi	HD2211	
	National	DM9093	
	Raytheon	RM993	
	SW	SW705	
	TI	SN158093	
		SN159093	
9094	National	DM9094	
	Raytheon	RM994	
	SW	SW708	
	TI	SN158094	
		SN159094	
9097	National	DM9097	
	Raytheon	RM997	
	SW	SW709	
	TI	SN158097	
		SN159097	
9099	Hitachi	HD2210	
	National	DM9099	
	Raytheon	RM999	
	SW	SW706	
	TI	SN158099	
		SN159099	
9135	National	DM935	
9157	National	DM957	
	SW	SW957	
9158	National	DM958	
	SW	SW958	
93H00	National	DM74LS195	
	TI	SN54S195	
		SN74S195	
93L00	AMD	93L00	
	National	DM74L00	
93L01	AMD	93L01	
	National	DM8301	
		DM9301	
93L08	AMD	93L08	
93L09	National	DM8309	
		DM9309	
93L10	AMD	93L10	
	National	DM76L75	
		DM86L75	
93L11	AMD	93L11	
	National	DM54L154A	
		DM74L154A	
93L12	AMD	93L12	
	National	DM8312	
		DM9312	
93L14	AMD	93L14	
93L16	AMD	93L16	
	National	DM76L76	
		DM86L76	
93L18	AMD	93L18	
	National	DM8318	
		DM9318	
93L21	AMD	93L21	
93L22	AMD	93L22	
	National	DM54L157A	
		DM74L157A	
93L24	AMD	93L24	
93L28	AMD	93L28	
93L34	AMD	93L34	
	National	DM8334	
		DM9334	
93L38	AMD	93L38	
93L40	AMD	93L40	
93L41	AMD	93L41	
	National	DM54181	
		DM74181	
93L60	AMD	93L60	
93L66	AMD	93L66	
93S00	National	DM74S195	
	TI	SN54S195	
		SN74S195	
93S10	AMD	93S10	
	National	DM54LS160	
		DM74LS160	
93S12	AMD	93S12	
	National	DM8312	
		DM9312	
93S138	National	DM74S138	
	TI	SN54S138	
		SN74S138	
93S139	National	DM74S139	
	TI	SN54S139	
		SN74S139	
93S151	National	DM74S151	
	TI	SN54S151	
		SN74S151	
93S153	National	DM74S153	
	TI	SN54S153	
		SN74S153	
93S157	National	DM74S157	
	TI	SN54S157	
		SN74S157	
93S158	National	DM74S158	
	TI	SN54S158	
		SN74S158	
93S16	AMD	93S16	
	National	DM54LS161	
		DM74LS161	
93S174	National	DM74S174	
	TI	SN54S174	
		SN74S174	
93S175	National	DM74S175	
	TI	SN54S175	
		SN74S175	
93S194	National	DM74S194	
	TI	SN54S194	
		SN74S194	
93S21	AMD	93S21	
	National	DM74S139	

♦ Discontinued

Bold face device numbers indicate manuracturers' data is provided in the IC Master on the pages noted.

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Manufacturer Device	Replacement Source	Replacement Device	IC Master Page
93S22	AMD	93S22	
	National	DM74S157	
		DM74S22	
	TI	SN54S157	
		SN74S157	
93S251	National	DM74S251	
	TI	SN54S251	
		SN74S251	
93S253	National	DM74S253	
93S257	National	DM74S257	
	TI	SN54S257	
		SN74S257	
93S258	National	DM74S258	
	TI	SN54S251	
		SN74S258	
93S41	National	DM54181	
		DM74181	
	TI	SN54S181	
		SN74S181	
93S42	National	DM74S182	
	TI	SN54S182	
		SN74S182	
93S46	National	DM7160	
		DM8160	
93S47	National	DM7160	
		DM74S47	
		DM8160	
93S48	AMD	93S48	
930	National	DM930	
9300	AMD	9300	
	ITT	ITT9300	
	Motorola	MC9300	
	National	DM8300	
		DM9300	
	Raytheon	RC9300	
		RM9300	
	TI	SN54195	
		SN74195	
9301	AMD	9301	
	ITT	ITT9301	
	Motorola	MC9301	
	National	DM8301	
		DM9301	
	TI	SN29301	
		SN39301	
9304	AMD	9304	
	ITT	ITT9304	
	Motorola	MC9304	
	Raytheon	RC9304	
		RM9304	
9306	AMD	9306	
	Motorola	MC9306	
9307	Motorola	MC9307	
	National	DM5448	
		DM7448	
9308	AMD	9308	
	ITT	ITT9308	
	Motorola	MC9308	
	Raytheon	RC9308	
		RM9308	
	TI	SN29308	
		SN39038	
9309	AMD	9309	
	Motorola	MC9309	
	National	DM8309	
		DM9309	
	TI	SN29309	
		SN39309	
9310	AMD	9310	
	Motorola	MC8310	
		MC9310	
	National	DM74160	
		DM8310	
		DM9310	
	Raytheon	RC9310	
		RM9310	
	TI	SN54160	
9310	TI	SN74160	
9311	AMD	9311	
	ITT	ITT9311	
	Motorola	MC8311	
		MC9311	
	National	DM8311	
		DM9311	
	Raytheon	RC9311	
		RM9311	
	TI	SN54154	
		SN74154	
9312	AMD	9312	
	ITT	ITT9312	
	Motorola	MC9312	
	National	DM8312	
		DM9312	
	Raytheon	RC9312	
		RM9312	
	Signetics	8230	
	TI	SN29312	
		SN39312	
9314	AMD	9314	
	Motorola	MC9314	
93141	National	DM54141	
		DM74141	
	TI	SN74141	
93145	ITT	ITT74145	
	Motorola	MC83145	
		MC93145	
	National	DM54145	
		DM74145	
	Raytheon	54145	
		74145	
	TI	SN54145	
		SN74145	
9315	Motorola	MC8315	
		MC9315	
	National	DM5441	
		DM7441A	
	Signetics	7441	
	TI	SN74141	
93150	ITT	ITT74150	
	Motorola	MC83150	
		MC93150	
	National	DM54150	
		DM74150	
	Raytheon	54150	
		74150	
	TI	SN54150	
		SN74150	
93151	ITT	ITT74151	
	Motorola	MC83151	
		MC93151	
	National	DM54151	
		DM74151	
	Raytheon	54151	
		74151	
	TI	SN54151A	
		SN74151A	
93152	Motorola	MC83152	
		MC93152	
	Raytheon	54152	
		74152	
	TI	SN54152A	
93153	ITT	ITT74153	
	Motorola	MC83153	
		MC93153	
	National	DM54153	
		DM74153	
	Raytheon	54153	
		74153	
	TI	SN54153	
		SN74153	
93155	National	DM54155	
		DM74155	
	Raytheon	54155	
		74155	
	TI	SN54155	
		SN74155	
93156	National	DM54156	
		DM74156	
93156	Raytheon	54156	
		74156	
	TI	SN54156	
		SN74156	
93157	National	DM54157	
		DM74157	
	TI	SN54157	
		SN74157	
9316	AMD	9316	
	ITT	ITT9316	
	Motorola	MC8316	
		MC9316	
	National	DM8316	
		DM9316	
	Raytheon	RC9316	
		RM9316	
	TI	SN54161	
		SN74161	
93160	National	DM54160	
		DM74160	
	TI	SN54160	
		SN74160	
93161	National	DM54161	
		DM74161	
	TI	SN54161	
		SN74161	
93162	National	DM54162	
		DM74162	
	TI	SN54162	
		SN74162	
93163	National	DM54163	
		DM74163	
	Raytheon	54163	
		74163	
	TI	SN54163	
		SN74163	
93164	AMD	SN74164	
	Motorola	MC83164	
		MC93164	
	National	DM54164	
		DM74164	
	TI	SN54164	
		SN74164	
93165	Motorola	MC83165	
	National	DM54165	
		DM74165	
	Raytheon	54165	
		74165	
	TI	SN54165	
		SN74165	
93166	National	DM54166	
		DM74166	
	Raytheon	54166	
		74166	
	TI	SN54166	
		SN74166	
9317B	National	DM5447	
		DM7447	
	TI	SN5447A	
		SN7447A	
9317C	National	DM5446	
		DM7446	
	TI	SN5446A	
		SN7446A	
93170	National	DM74170	
	Raytheon	54170	
		74170	
	TI	SN54170	
		SN74170	
93174	AMD	SN74174	
	National	DM54174	
		DM74174	
	Raytheon	54174	
		74174	
	TI	SN54174	
		SN74174	
93175	AMD	SN74175	
	National	DM54175	
		DM74175	
	Raytheon	54175	
		74175	
93175	TI	SN54175	
		SN74175	
93176	Motorola	MC93176	
	National	DM54176	
		DM74176	
	TI	SN54176	
		SN74176	
93177	Motorola	MC83177	
		MC93177	
	National	DM54177	
		DM74177	
	TI	SN54177	
		SN74177	
93178	Motorola	MC83178	
		MC93178	
	TI	SN54178	
		SN74178	
93179	Motorola	MC83179	
		MC93179	
	TI	SN54179	
		SN74179	
9318	AMD	9318	
	Motorola	MC9318	
	National	DM8318	
		DM9318	
	TI	SN54148	
		SN74148	
93180	ITT	ITT74180	
	Motorola	MC83180	
		MC93180	
	National	DM54180	
		DM74180	
	Raytheon	54180	
		74180	
	TI	SN54180	
		SN74180	
93190	National	DM54190	
		DM74190	
	Raytheon	54190	
		74190	
	TI	SN54190	
		SN74190	
93191	National	DM54191	
		DM74191	
	Raytheon	54191	
		74191	
	TI	SN54191	
		SN74191	
93194	AMD	SN74194	
	National	DM54194	
		DM74194	
	Raytheon	54194	
		74194	
	TI	SN54194	
		SN74194	
93195	National	DM54195	
		DM74195	
	TI	SN54195	
		SN74195	
93196	Motorola	MC7280	
	National	DM54196	
		DM74196	
	TI	SN54196	
		SN74196	
93197	Motorola	MC8280	
	National	DM54197	
		DM74197	
	TI	SN54197	
		SN74197	
93198	Motorola	MC8316	
	National	DM54198	
		DM74198	
	Raytheon	54198	
		74198	
	Signetics	54198	
		74198	
	TI	SN54198	
		SN74198	
93199	National	DM54199	
		DM74199	
	Raytheon	54199	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Fairchild Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
93199	Raytheon	74199	
	TI	SN54199	
		SN74199	
932	National	DM932	
9321	AMD	9321	
	National	DM54LS139	
		DM74LS139	
9322	AMD	9322	
	ITT	ITT9322	
	Motorola	MC8322	
		MC9322	
	National	DM74157	
		DM8322	
		DM9322	
	Raytheon	RC9322	
		RM9322	
		54157	
		74157	
	TI	SN54157	
		SN74157	
9324	AMD	9324	
	Motorola	MC9324	
9325	National	DM54141	
		DM74141	
	Signetics	54141	
		74141	
	TI	SN74141	
9328	AMD	9328	
	ITT	ITT9328	
	Motorola	MC9328	
	Signetics	N8277	
933	National	DM933	
9334	AMD	9334	
	Motorola	MC9334	
	National	DM9334	
	TI	SN54259	
		SN74259	
9338	AMD	9338	
9340	AMD	9340	
93400	Motorola	MCM4012	
93403	AMD	93403	
	Intersil	IM5501	
	MMI	6560	
	Motorola	MCM4064	
		MC4064	
	National	**DM7489**	**704**
		DM7489	**741**
	Signetics	N82S25	
	TI	SN74S289	
		SN7489	
93404	Signetics	82S25	
♦93406	Intersil	IM5603	
	MMI	6200	
	Motorola	MCM4006	
	Signetics	N82S226	
	TI	SN54187	
		SN74187	
93407	Motorola	MC4004	
		MC4304	
	TI	SN5481A	
		SN7481A	
9341	AMD	9341	
	Motorola	MC8341	
		MC9341	
	National	DM54181	
		DM74181	
	Raytheon	RC9341	
		RM9341	
		54181	
		74181	
	Signetics	54181	
		74181	
	TI	SN54181	
		SN74181	
♦93410	Motorola	MCM4056	
	Signetics	N93410	
		54S301	
93410	Signetics	74S301	
	TI	SN54S301	
		SN74S300	
		SN74S301	
93411	Intersil	IM5533	
	MMI	5530	
		6530	
		6531	
	National	**DM54S206**	**751**
		DM74S206	**751**
	Raytheon	RC5330	
		RM5330	
	Signetics	82S17	
	TI	SN74S200A	
♦93412	Intersil	IM5600	
	TI	SN54S214	
		SN74S214	
93415	**Intel**	**2115**	**683**
	Intersil	IM5508	
	NEC	μPB2205	
	Raytheon	RC5500	
		RM5500	
	RCA	MWS5001	
		MWS5501	
	Signetics	N82S10	
	TI	SN54S314	
		SN74S314	
93415A	Signetics	93415A	
	TI	SN74S314	
93416	Harris	HPROM1024A	
	Intel	**3601**	**695**
	Intersil	IM5603	
	MMI	6300	
	Signetics	N82S126	
	TI	**SN74S387**	**861**
93417	**Harris**	**HM7610**	**682**
	MMI	5300	
		6300	
	National	**DM54S387**	**708**
		DM74S387	**708**
	TI	**SN54S387**	**861**
		SN74S387	**861**
9342	AMD	9342	
	ITT	ITT74182	
	Motorola	MC8342	
		MC9342	
	National	DM54182	
		DM74182	
	Raytheon	RM9342	
		54182	
		74182	
	Signetics	54182	
		74182	
	TI	SN54182	
		SN74182	
93421	Intersil	IM5523	
	MMI	5531	
		6531	
	National	**DM54S200**	**704**
		DM74S200	**704**
	Raytheon	RC5340	
		RM5340	
	Signetics	N82S16	
	TI	SN54S201	
		SN74S200A	
		SN74S201	
93425	**Intel**	**2125**	**683**
	RCA	MWS5001	
		MWS5501	
	TI	SN74S214	
93425A	Signetics	93425	
	TI	SN74S214	
93426	Harris	HPROM1024	
	Intel	**3621**	**695**
	Intersil	IM5623	
	MMI	6301	
	Signetics	N82S129	
	TI	**SN54S287**	**861**
		SN74S287	**861**
93427	**Harris**	**HM7611**	**682**
	MMI	5301	
93427	MMI	6301	
	National	**DM54S287**	**708**
		DM74S287	**708**
	TI	**SN54S287**	**861**
		SN74S287	**861**
93433	Motorola	MC4004	
	TI	SN83433	
		SN93433	
♦93434	Intersil	IM5600	
	MMI	5230	
		6230	
	Motorola	MCM4002	
	National	DM5487	
		DM7488	**702**
	Signetics	8223	
	TI	SN5488A	
		SN7488A	
93435	MMI	5560	
		6560	
	Motorola	MC4064	
	TI	SN7489	
93436	**Harris**	**HM7621**	**682**
	Intel	**3602**	**697**
	Intersil	IM5604	
	MMI	5305	
		6305	
	National	**DM54S570**	**710**
		DM74S570	**710**
	Signetics	82S130	
	TI	SN54S270	
		SN74S270	
93438	**Harris**	**HM7640**	**682**
	MMI	5340	
		6340	
	National	**DM77S295**	**714**
		DM87S295	**714**
	TI	**SN54S475**	**864**
		SN74S475	**864**
93446	**Harris**	**HM7621**	**682**
	Intel	**3622**	**697**
	MMI	5306	
		6306	
	National	**DM54S571**	**710**
		DM74S571	**710**
	Signetics	82S131	
93448	**Harris**	**HM7641**	**682**
	MMI	5341	
		6341	
	National	**DM77S296**	**714**
		DM87S296	**714**
	TI	**SN54S474**	**864**
		SN74S474	**864**
9345	ITT	ITT7445	
	Motorola	MC9345	
	National	DM5445	
		DM7445	
	Raytheon	5445	
		7445	
	Signetics	5445	
		7445	
	TI	SN5445A	
		SN7445A	
93452	MMI	5352	
		6352	
	National	**DM54S572**	**702**
		DM54S572	**712**
		DM74S572	**702**
		DM74S572	**712**
93453	MMI	5353	
		6353	
	National	**DM54S573**	**702**
		DM54S573	**702**
		DM54S573	**712**
		DM74S573	**712**
9349	Raytheon	54180	
		74180	
	Signetics	54180	
		74180	
	TI	SN54180	
		SN74180	
935	National	DM935	
9352	ITT	ITT7442	
	Motorola	MC8352	
		MC9352	
	National	DM5442	
		DM7442	
	Signetics	5442	
		7442	
	TI	SN5442	
		SN7442	
9353	ITT	ITT7443	
	Motorola	MC8353	
		MC9353	
	Signetics	5443	
		7443	
	TI	SN5443	
		SN7443	
9354	ITT	ITT7444	
	Motorola	MC8354	
		MC9354	
	Signetics	5444	
		7444	
	TI	SN5444A	
		SN7444A	
9355	Motorola	MC8355	
9357	Motorola	MC8357	
		MC9357	
9357A	ITT	ITT7446A	
	Motorola	MC9357A	
	National	DM5446A	
		DM7446A	
	Signetics	7446	
	TI	SN5446A	
		SN7446A	
9357B	ITT	ITT7447A	
	Motorola	MC9357B	
	National	DM5447A	
		DM7447A	
	Signetics	7447	
	TI	SN5447A	
		SN7447A	
9358	ITT	ITT7448	
	Motorola	MC8358	
		MC9358	
	National	DM5448	
		DM7448	
	Signetics	7448	
	TI	SN5448	
		SN7448	
9359	Motorola	MC8359	
		MC9359	
936	National	DM936	
9360	AMD	9360	
	ITT	ITT74192	
	Motorola	MC8360	
		MC9360	
	National	DM54192	
		DM74192	
	Raytheon	RC9360	
		RM9360	
		54192	
		74192	
	Signetics	54192	
		74192	
	TI	SN74192	
9366	AMD	9366	
	ITT	ITT74193	
	Motorola	MC8366	
		MC9366	
	National	DM54193	
		DM74193	
	Raytheon	RM9366	
		54193	
		74193	
	Signetics	54193	
		74193	
	TI	SN54193	
		SN74193	
937	National	DM937	
9375	ITT	ITT7475	
	Motorola	MC9375	
	National	DM5475	

♦ Discontinued

Bold face device numbers indicate manuracturers' data is provided in the IC Master on the pages noted.

Fairchild Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
9375	National	DM7475	
	Signetics	5475	
		7475	
	TI	SN5475	
		SN7475	
9377	Motorola	MC8377	
		MC9377	
	National	DM54LS77	
		DM74LS77	
9380	ITT	ITT7480	
	Motorola	MC8380	
		MC9380	
	Signetics	5480	
		7480	
	TI	SN5480	
		SN7480	
9382	ITT	ITT7482	
	Motorola	MC8382	
		MC9382	
	National	DM7482	
	TI	SN5482	
		SN7482	
9383	ITT	ITT7483	
	Motorola	MC8383	
		MC9383	
	National	DM5483	
		DM7483	
	Signetics	5483	
		7483	
	TI	SN5483A	
		SN7483A	
9385	National	DM5485	
		DM7485	
939	National	DM939	
9390	ITT	ITT7490	
	Motorola	MC8390	
		MC9390	
	National	DM5490	
		DM7490	
	Signetics	5490	
		7490	
	TI	SN5490A	
		SN7490A	
9391	ITT	ITT7491	
	Motorola	MC8391	
		MC9391	
	National	DM5491	
		DM7491	
	Signetics	5491	
		7491	
	TI	SN5491A	
		SN7491A	
9392	ITT	ITT7492	
	Motorola	MC8392	
		MC9392	
	National	DM5492	
		DM7492	
	Signetics	9392	
		9392	
	TI	SN5492A	
		SN7492A	
9393	ITT	ITT7493	
	Motorola	MC8393	
		MC9393	
	National	DM5493	
		DM7493	
	Signetics	5493	
		7493	
	TI	SN5493	
		SN7493	
9394	ITT	ITT7494	
	Motorola	MC8394	
		MC9394	
	Signetics	5494	
		7494	
	TI	SN5494	
		SN7494	
9395	ITT	ITT7495A	
	Motorola	MC8395	
		MC9395	
	National	DM5495	
		DM7495	
	Signetics	5495	
		7495	
	TI	SN5495A	
		SN7495A	
9396	ITT	ITT7496	
	Motorola	MC8396	
		MC9396	
	National	DM5496	
		DM7496	
	Signetics	5496	
		7496	
	TI	SN5496	
		SN7496	
944	National	DM944	
945	National	DM945	
946	National	DM946	
948	National	DM948	
949	National	DM949	
95H90	Plessey	SP640	
95H91	Plessey	SP641	
95H92	Plessey	SP642	
95H93	Plessey	SP643	
96L02	National	DM9602	
96S02	National	DM8602	
		DM9602	
9600	AMD	9600	
9601	AMD	9601	
	ITT	ITT9601	
	Motorola	MC9601	
	National	DM8601	
		DM9601	
	Raytheon	RF8601	
		RF9601	
	TI	SN29601	
9602	AMD	9602	
	ITT	ITT9602	
	Motorola	MC9602	
	National	DM8602	
		DM9602	
	Raytheon	RF8602	
		RF9602	
9603	ITT	ITT74121	
	Motorola	MC8603	
		MC9603	
	National	DM54121	
		DM74121	
	Signetics	54121	
		74121	
	TI	SN54121	
		SN74121	
961	National	DM961	
9614	AMD	9614	
	ITT	ITT9614	
	TI	SN55114	
9615	AMD	9615	
	ITT	ITT9615	
	TI	SN55115	
9616	AMD	9616	
9617	AMD	9617	
96176	Motorola	MC83176	
962	National	DM962	
9620	AMD	9620	
9621	AMD	9621	
	Raytheon	RC9621	
		RM9621	
9622	Raytheon	RC9622	
		RM9622	
963	National	DM963	
9664	Signetics	7524	
9665	Signetics	7525	
	Sprague	ULN-2001	
9666	Sprague	ULN-2002	
9667	Sprague	ULN-2003	
9930	Hitachi	HD2204	
	Raytheon	RM930	
	SW	SW930	
9930	TI	SN15830	
		SN15930	
9932	Hitachi	HD2201	
	Raytheon	RM932	
	SW	SW932	
	TI	SN15832	
		SN15932	
9933	Hitachi	HD2202	
	Raytheon	RM933	
	SW	SW933	
	TI	SN15833	
		SN15933	
9935	Hitachi	HD2208	
	Raytheon	RM935	
	SW	SW935	
	TI	SN15835	
		SN15935	
9936	Hitachi	HD2206	
	Raytheon	RM936	
	SW	SW936	
	TI	SN15836	
		SN15936	
9937	Raytheon	RM937	
	SW	SW937	
	TI	SN15837	
		SN15937	
9941	Raytheon	RM941	
	SW	SW941	
	TI	SN15841	
		SN15941	
9944	Hitachi	HD2209	
	Raytheon	RM944	
	SW	SW944	
	TI	SN15844	
		SN15944	
9945	Hitachi	HD2205	
	Raytheon	RM945	
	SW	SW945	
	TI	SN15845	
		SN15945	
9946	Hitachi	HD2203	
	Raytheon	RM946	
	SW	SW946	
	TI	SN15846	
		SN15946	
9948	Raytheon	RM948	
	SW	SW948	
	TI	SN15848	
		SN15948	
9949	SW	SW949	
	TI	SN15849	
		SN15949	
9950	Raytheon	RM950	
	SW	SW950	
	TI	SN15850	
		SN15950	
9951	Raytheon	RM951	
	SW	SW951	
	TI	SN15851	
		SN15951	
9961	Raytheon	RM961	
	SW	SW961	
	TI	SN15861	
		SN15961	
9962	Hitachi	HD2207	
	Raytheon	RM962	
	SW	SW962	
	TI	SN15862	
		SN15962	
9963	Raytheon	RM963	
	SW	SW963	
	TI	SN15863	
		SN15963	

General Instrument

Manufacturer Device	Replacement Source	Device	IC Master Page
♦AY5-1012	TI	TMS6011	
AY5-1013	**AMI**	**S1883**	**400**
		S1883	**401**
	Western	TR1402	
AY5-1013	Western	TR1602	
AY5-9100	Plessey	MP9100	
AY5-9200	Plessey	MP9200	
DL9-1402	SGS	M141	
	Signetics	2502	
♦DL9-1403	SGS	M136	
♦DL9-1404	SGS	M130	
		M141	
MEM4001	RCA	CD4001	
MEM4007	RCA	CD4007	
MEM4011	RCA	CD4011	
MEM4013	RCA	CD4013	
MEM4016	RCA	CD4016	
		CD4066	
MEM4049	RCA	CD4049	
MEM4050	RCA	CD4050	
MEM4051	RCA	CD4051	
MEM4053	RCA	CD4053	
RA3-4256	EMM/Semi	RA3-4256	
RA3-4402	EMM/Semi	4402	
♦RA9-1101	Intersil	IM7501	
		IM7511	
	Mostek	MK4007	
♦RA9-1103	Signetics	1103	
♦RO1-2048	AMI	S8773	
RO3-16384	**AMI**	**S8996**	**634**
	EMM/Semi	RO3-16384	
RO3-4096	EMM/Semi	RO3-4096	
RO3-5120	EMM/Semi	RO3-5120	
RO3-8316	EMM/Semi	RO3-8316	
	Mostek	MK31000	
RO5-2240	Mostek	MK2302	
RO5-8192	**AMI**	**S8865**	**634**
♦RO6-1024	AMI	S8773	
♦RO6-2048	AMI	S8773	

Harris Semiconductor

Manufacturer Device	Replacement Source	Device	IC Master Page
HA-2055	Datel	AM-405	
HA-2065	Datel	AM-406	
HA-2425	Datel	SHM-IC-1	
HA-2500	Intersil	2500	
HA-2502	Intersil	2502	
HA-2505	Datel	AM-450	
	Intersil	2505	
HA-2520	**AD**	**AD509**	**574**
	Intersil	2520	
HA-2522	**AD**	**AD509**	**574**
	Intersil	2522	
HA-2525	**AD**	**AD509**	**574**
	Datel	AM-452	
	Intersil	2525	
HA-2605	Datel	AM-460	
HA-2625	**AD**	**AD507**	**574**
	Datel	AM-462	
HA-2645	Datel	AM-464	
HA-2650	Teledyne S	1558	
HA-2655	Teledyne S	1458	
HA-2905	Datel	AM-490	
HA-4741	**Raytheon**	**HA4741**	**598**
HD14518	RCA	CD4518	
	SSS	SCL4518	
HD14520	RCA	CD4520	
	SSS	SCL4520	
HD14529	RCA	CD4052	
HD4000	Motorola	MC14000	
	RCA	CD4000	
	SSS	SCL4000	
HD4001	Motorola	MC14001	
	National	CD4001	
	RCA	CD4001	
	SSS	SCL4001	
HD4002	Motorola	MC14002	
	National	CD4002	
	RCA	CD4002	
	SSS	SCL4002	
HD4006	RCA	CD4006	
	SSS	SCL4006	
HD4007	Motorola	MC14007	
	National	CD4007	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Harris Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
HD4007	RCA	CD4007	
	SSS	SCL4007	
HD4008	RCA	CD4008	
HD4011	National	CD4011	
	RCA	CD4011	
	SSS	SCL4011	
HD4012	Motorola	MC14012	
	National	CD4012	
	RCA	CD4012	
	SSS	SCL4012	
HD4013	Motorola	MC14013	
	National	CD4013	
	RCA	CD4013	
	SSS	SCL4013	
HD4014	National	CD4014	
	RCA	CD4014	
	SSS	SCL4014	
HD4015	National	CD4015	
	RCA	CD4015	
	SSS	SCL4015	
HD4017	National	CD4017	
	RCA	CD4017	
	SSS	SCL4017	
HD4018	National	CD4018	
	RCA	CD4018	
	SSS	SCL4018	
HD4019	National	CD4019	
	RCA	CD4019	
	SSS	SCL4019	
HD4020	National	CD4020	
	RCA	CD4020	
	SSS	SCL4020	
HD4021	National	CD4021	
	RCA	CD4021	
	SSS	SCL4021	
HD4022	National	CD4022	
	RCA	CD4022	
	SSS	SCL4022	
HD4023	Motorola	MC14023	
	National	CD4023	
	RCA	CD4023	
	SSS	SCL4023	
HD4024	National	CD4024	
	RCA	CD4024	
	SSS	SCL4024	
HD4025	Motorola	MC14025	
	National	CD4025	
	RCA	CD4025	
	SSS	SCL4025	
HD4027	National	CD4027	
	RCA	CD4027	
	SSS	SCL4027	
HD4028	National	CD4028	
	RCA	CD4028	
	SSS	SCL4028	
HD4029	National	CD4029	
	RCA	CD4029	
	SSS	SCL4029	
HD4030	National	CD4030	
	RCA	CD4030	
		CD4070	
	SSS	SCL4030	
HD4035	National	CD4035	
	RCA	CD4035	
	SSS	SCL4035	
HD4040	National	CD4040	
	RCA	CD4040	
	SSS	SCL4040	
HD4042	National	CD4042	
	SSS	SCL4042	
HD4049	National	CD4049	
	RCA	CD4049	
	SSS	SCL4049	
HD4050	National	CD4050	
	RCA	CD4050	
	SSS	SCL4050	
HD4066	National	CD4066	
	RCA	CD4066	
	SSS	SCL4066	
HD54C00	National	MM54C00	
		MM54C00	
HD54C02	National	MM54C02	
HD54C04	National	MM54C04	
HD54C08	National	MM54C08	
HD54C10	National	MM54C10	
HD54C107	National	MM54C107	
HD54C151	National	MM54C151	
HD54C154	National	MM54C154	
HD54C157	National	MM54C157	
HD54C160	National	MM54C160	
	SSS	SCL4160	
HD54C161	National	MM54C161	
	SSS	SCL4161	
HD54C162	National	MM54C162	
	SSS	SCL4162	
HD54C163	National	MM54C163	
	SSS	SCL4163	
HD54C164	National	MM54C164	
HD54C165	National	MM54C165	
HD54C173	National	MM54C173	
HD54C174	National	MM54C174	
HD54C175	National	MM54C175	
HD54C192	National	MM54C192	
HD54C193	National	MM54C193	
HD54C195	National	MM54C195	
HD54C20	National	MM54C20	
HD54C30	National	MM54C30	
HD54C32	National	MM54C32	
HD54C42	National	MM54C42	
HD54C48	National	MM54C48	
HD54C73	National	MM54C73	
HD54C74	National	MM54C74	
HD54C76	National	MM54C76	
HD54C83	National	MM54C83	
HD54C85	National	MM54C85	
HD54C86	National	MM54C86	
HD54C89	**National**	**MM54C89**	**805**
HD54C901	National	MM54C901	
HD54C902	National	MM54C902	
HD54C903	National	MM54C903	
HD54C904	National	MM54C904	
HD54C906	National	MM54C906	
HD54C907	National	MM54C907	
HD54C95	National	MM54C95	
HD6101	Intersil	IM6101	
HD6101A	Intersil	IM6101A	
HD6101C	Intersil	IM6101C	
HD6402	Intersil	IM6402	
HD6402A	Intersil	IM6402A	
HD6402C	Intersil	IM6402C	
HD6403	Intersil	IM6403	
HD6403A	Intersil	IM6403A	
HD6403C	Intersil	IM6403C	
HD70C95	National	MM70C95	
HD70C97	National	MM70C97	
HD74C00	National	MM54C95	
		MM74C00	
	RCA	CD4011	
HD74C02	National	MM74C02	
	RCA	CD4001	
HD74C04	National	MM74C04	
	RCA	CD4069	
	SSS	SCL4069	
HD74C08	National	MM74C08	
HD74C10	National	MM74C10	
	RCA	CD4023	
HD74C107	National	MM74C107	
HD74C14	National	MM74C14	
	SSS	SCL4584	
HD74C151	National	MM74C151	
HD74C154	National	MM74C154	
HD74C157	National	MM74C157	
HD74C160	Fairchild	F40160	
	National	MM74C160	
	SSS	SCL4160	
HD74C161	Fairchild	F40161	
	National	MM74C161	
	SSS	SCL4161	
HD74C162	Fairchild	F40162	
	National	MM74C162	
	SSS	SCL4162	
HD74C163	Fairchild	F40163	
	National	MM74C163	
	SSS	SCL4163	
HD74C164	National	MM74C164	
HD74C165	National	MM74C165	
HD74C173	National	MM74C173	
	RCA	CD4076	
HD74C174	Fairchild	F40174	
	National	MM74C174	
HD74C175	Fairchild	F40175	
	National	MM74C175	
HD74C192	Fairchild	F40192	
	National	MM74C192	
	RCA	CD40192	
HD74C193	Fairchild	F40193	
	National	MM74C193	
	RCA	CD40193	
HD74C195	Fairchild	F40195	
	National	MM74C195	
HD74C20	National	MM74C20	
	RCA	CD4012	
HD74C200	**National**	**MM74C200**	**808**
HD74C221	National	MM74C221	
HD74C30	National	MM74C30	
HD74C32	National	MM74C32	
HD74C42	National	MM74C42	
	RCA	CD4028	
HD74C48	National	MM74C48	
HD74C73	National	MM74C73	
HD74C74	National	MM74C74	
	RCA	CD4013	
HD74C76	National	MM74C76	
	RCA	CD4027	
HD74C83	National	MM74C83	
HD74C85	Fairchild	F40085	
	National	MM74C85	
HD74C86	National	MM74C86	
HD74C89	**National**	**MM74C89**	**805**
HD74C901	National	MM74C901	
HD74C902	National	MM74C902	
HD74C903	National	MM74C903	
HD74C904	National	MM74C904	
HD74C906	National	MM74C906	
HD74C907	National	MM74C907	
HD74C95	National	MM74C95	
HD80C95	National	MM70C95	
HD80C97	Fairchild	F40097	
	National	MM70C97	
		MM80C97	
HI1818	RCA	CD4051	
HI1828	RCA	CD4052	
HI5040	Intersil	IH5040	
HI5041	Intersil	IH5041	
HI5042	Intersil	IH5042	
HI5044	Intersil	IH5044	
HI5045	Intersil	IH5045	
HI5046	Intersil	IH5046	
HI5047	Intersil	IH5047	
HI5048	Intersil	IH5048	
HI5049	Intersil	IH5049	
HI5050	Intersil	IH5050	
HI5051	Intersil	IH5051	
HI506	RCA	CD4067	
	Siliconix	DG506	
HI506A	Datel	MX-1606	
HI507	RCA	CD4097	
	Siliconix	DG507	
HI507A	Datel	MXD-807	
HI508	RCA	CD4051	
HI508A	Datel	MX-808	
HI509	RCA	CD4052	
HI509A	Datel	MXD-409	
HM6100	Intersil	IM6100	
HM6100A	Intersil	IM6100A	
HM6100C	Intersil	IM6100C	
HM7602	AMD	AM27S09	
	MMI	5330	
		6330	
HM7602	**National**	**DM7577**	**702**
		DM8577	**702**
	Signetics	N82S23	
	TI	**SN54S188**	**860**
		SN74S188	**860**
HM7603	MMI	5331	
		6331	
	Signetics	N82S123	
	TI	SN54S288	
		SN74S288	
HM7610	**Intel**	**3601-1**	**695**
	Intersil	IM5603	
	MMI	5300	
		6300	
	National	**DM54S387**	**708**
		DM74S387	**708**
	Signetics	N82S126	
	TI	**SN54S387**	**861**
		SN74S387	**861**
HM7611	**Intel**	**3621-1**	**695**
	Intersil	IM5623	
	MMI	5301	
		6301	
	National	DM7574	
	Signetics	82S129	
	TI	**SN54S287**	**861**
		SN74S287	**861**
HM7620	**Intel**	**3602**	**697**
	MMI	5305	
		6305	
	National	**DM54S570**	**710**
		DM74S570	**710**
	Signetics	82S130	
	TI	SN54S270	
		SN74S270	
HM7621	**Intel**	**3622**	**697**
	MMI	5306	
		6306	
	National	**DM54S571**	**710**
		DM74S571	**710**
	Signetics	82S131	
	TI	SN54S370	
		SN74S370	
HM7640	Intel	3604	
	MMI	5340	
		6340	
	National	**DM77S295**	**714**
		DM87S295	**714**
	RCA	CD40032	
	TI	**SN54S475**	**864**
		SN74S475	**864**
HM7641	Intel	3624	
	MMI	5341	
		6341	
	National	**DM77S296**	**714**
		DM87S296	**714**
	TI	**SN54S474**	**864**
		SN74S474	**864**
HM7642	**Intel**	**3605**	**699**
	MMI	5352	
		6352	
	National	**DM54S572**	**702**
		DM54S572	**712**
		DM74S572	**702**
		DM74S572	**712**
	Signetics	82S136	
HM7643	**Intel**	**3625**	**699**
	MMI	5353	
		6353	
	National	**DM54S573**	**702**
		DM54S573	**702**
		DM54S573	**712**
		DM74S573	**712**
	Signetics	82S137	
HPROM0512	TI	SN54186	
		SN74186	
HPROM1024	**Intel**	**3621**	**695**
	MMI	5301	
		6301	
	Signetics	N82S129	
	TI	**SN54S287**	**861**

♦ Discontinued

Bold face device numbers indicate manuracturers' data is provided in the IC Master on the pages noted.

Manufacturer Device	Replacement Source	Device	IC Master Page
Harris Semiconductor (cont'd)			
HPROM1024	**TI**	**SN74S287**	**861**
HPROM1024A	Fairchild	93416	
	Intel	M3601	
		3601	**695**
	Intersil	IM5603	
	MMI	5300	
		6300	
	Signetics	N82S126	
	TI	**SN54S387**	**861**
		SN74S387	**861**
♦HPROM2048	Fairchild	93446	
	Intersil	IM5624	
	Signetics	N82S131	
HPROM2048A	AMD	AM27S08	
	Fairchild	93436	
	Signetics	N82S130	
HPROM8256	Intersil	IM5600	
	MMI	5330	
		6330	
	National	**DM7577**	**702**
		DM8577	**702**
	Signetics	N82S23	
	TI	**SN54S188**	**860**
		SN54188	
		SN74S188	**860**
		SN74188	
Hughes Aircraft, MOS Division			
HMPC1802	RCA	CDP1802	
Hybrid Systems			
ADC586-10	Teledyne S	8701	
ADC586-12	Teledyne S	8702	
ADC586-8	Teledyne S	8700	
Intel			
MCS-4	**National**	**FIPS**	**986**
1101	AMD	1101	
	Intersil	IM7501	
		IM7511	
	Mostek	MK4007	
	National	MM1101	
1103	**AMI**	**S1103**	**634**
		S146	**634**
	Fairchild	1103	
	Hitachi	HM3503	
	Nortec	1103	
	Rockwell	1103	
	Signetics	1103	
	Synertek	SY1103	
	TI	TMS1103	
1301	AMI	S8773	
1302	GI	RO5-1302	
1402	AMD	1402	
	AMI	S2502A	
	National	MM1402	
	Nortec	1402	
	SGS	M141	
	Signetics	2502	
	Synertek	SY1402	
1403	AMD	1403	
	National	MM1403	
	Nortec	1403	
	SGS	M136	
	Signetics	2503	
	Synertek	SY1403	
1404	AMD	1404	
	National	MM1404	
	Nortec	1404	
	SGS	M130	
1404	Signetics	2504	
	Synertek	SY1404	
1405	AMD	1405	
	Signetics	2505	
1406	AMD	1406	
1407	AMD	1407	
1504	AMI	S1685	
1506	AMD	1506	
1507	AMD	1507	
1702	AMD	1702	
	National	**MM1702**	**818**
1702A	AMD	1702A	
	Mostek	MK3702	
2101	AMD	2101	
	EA	EA2101	
	Hitachi	HM2101	
	National	**MM2101**	**756**
	RCA	MW4101	
	Synertek	SY2101	
	TI	**TMS2101**	**857**
		TMS4039	
2102	AMD	2102	
		9102	
	EA	EA2102	
	Fairchild	2102	
	Intersil	IM7552	
	Mostek	MK4102	
	National	**MM2102**	**759**
	SGS	M330	
	Signetics	2102	
	Synertek	SY2102	
	TI	TMS4033	
		TMS4034	
		TMS4035	
2102A	Signetics	21F02	
2104	Fairchild	4096	
	Mostek	MK4096	
	RCA	MW4104	
2107A	**TI**	**TMS4030**	**854**
		TMS4060	**854**
	Western	RM1701	
2107B	Intersil	7280	
	National	**MM5280**	**794**
	NEC	μPD411	
	RCA	MW4060	
	TI	**TMS4060**	**854**
2111	AMD	2111	
	EA	EA2111	
	National	**MM2111**	**768**
	RCA	MW4111	
	Synertek	SY2111	
	TI	TMS4042	
2112	AMD	2112	
	EA	EA2112	
	National	**MM2112**	**771**
	RCA	MW4112	
	Synertek	SY2112	
	TI	TMS4043	
2113	Synertek	SY2113	
2116	Mostek	MK4116	
2146	**AMI**	**S146**	**634**
2308	EA	EA2308	
	Mostek	MK30000	
2316	EMM/Semi	RO3-8316	
	GI	RO3-8316	
	Mostek	MK31000	
		MK34000	
2401	Synertek	SY2401	
2405	AMI	S1685	
	Synertek	SY2405	
2708	Mostek	MK3708	
3002	Signetics	N3002	
3101	AMD	AM27S02	
		3101	
	Intersil	IM5501	
	MMI	5560	
		6560	
	National	MM54S289	
		MM74S289	
	Signetics	N82S25	
		3101	
3101	TI	SN54S289	
		SN74S289	
3102	Fairchild	93400	
3104	Fairchild	93402	
3106	Fairchild	93421	
	Intersil	IM5523	
	MMI	6531	
	National	MM74S200	
	Raytheon	RC5340	
		RM5340	
	Signetics	82S16	
	TI	SN54S201	
		SN74S200A	
		SN74S201	
3107	Fairchild	93411	
	Intersil	IM5533	
	MMI	5530	
		6530	
	National	MM74S206	
	Raytheon	RC5330	
		RM5330	
	Signetics	S82S17	
		74S01	
		82S17	
	TI	SN54S301	
		SN74S300	
		SN74S301	
3110	TI	SN74S214	
		SN74S314	
3202	Fairchild	93401	
3207	ITT	ITT3207	
3207A	NEC	μPD246	
	Signetics	3207	
3212	TI	SN54S412	
		SN74S412	
3301	AMD	SN74186	
	Intersil	IM5603	
	MMI	H6200	
		5200	
	TI	SN54187	
		SN74187	
3301A	Signetics	82S226	
3304	MMI	6340	
	Signetics	82S215	
		8205	
3601	Fairchild	93416	
	Harris	**HM7610**	**682**
		HPROM1024A	
	Intersil	IM5603	
	MMI	5300	
		6300	
	Signetics	N82S126	
	TI	**SN54S387**	**861**
		SN74S387	**861**
3601-1	**National**	**DM54S387**	**708**
		DM74S387	**708**
3602	Fairchild	93436	
	Harris	**HM7620**	**682**
	MMI	5305	
		6305	
	National	**DM54S570**	**710**
		DM74S570	**710**
	Signetics	82S130	
3604	**Harris**	**HM7640**	**682**
	MMI	5340	
		6340	
		6340	
	National	**DM77S295**	**714**
		DM87S295	**714**
		SN54S475	
		SN74S475	
3605	**Harris**	**HM7642**	**682**
	MMI	5352	
		6352	
	National	**DM54S572**	**702**
		DM54S572	**712**
		DM74S572	**702**
		DM74S572	**712**
	Signetics	82S136	
3621	**Harris**	**HM7611**	**682**
	MMI	5301	
3621	MMI	6301	
	National	**DM54S287**	**708**
		DM74S287	**708**
	TI	**SN54S287**	**861**
		SN74S287	**861**
3622	Fairchild	93446	
	Harris	**HM7621**	**682**
	MMI	5306	
		6306	
	National	**DM54S571**	**710**
		DM74S571	**710**
	Signetics	82S131	
3624	**Harris**	**HM7641**	**682**
	MMI	5341	
		6341	
	National	**DM77S296**	**714**
		DM87S296	**714**
		SN54S474	
		SN74S474	
3625	**Harris**	**HM7643**	**682**
	MMI	5353	
		6353	
	National	**DM54S573**	**702**
		DM54S573	**702**
		DM54S573	**712**
		DM74S573	**712**
	Signetics	82S137	
4001	**Harris**	**HM7621**	**682**
	National	**INS4001**	**1059**
4002	**National**	**INS4002**	**1059**
4003	**National**	**INS4003**	**1059**
4004	**National**	**INS4004**	**1059**
4008	**National**	**INS4008**	**1059**
4009	**National**	**INS4009**	**1059**
4201	**National**	**DP4201**	**435**
4702	AMD	4702	
5201	SSS	SCL5424	
5801	SSS	SCL5437	
8080	AMD	9080	
	National	**DP8080A**	**1033**
		INS8080A	**1033**
	NEC	μPD8080	
	TI	**TMS8080**	**1097**
8212	AMD	8212	
	National	**DP8212**	**439**
	NEC	μPD8212	
	TI	SN54S412	
		SN74S412	
8216	AMD	8216	
8224	AMD	8224	
	National	**DP8224**	**447**
8226	AMD	8226	
8228	AMD	8228	
	National	**DP8228**	**453**
	TI	SN74S428	
8238	AMD	8238	
	National	**DP8238**	**453**
	TI	SN74S438	
8251	AMD	9551	
	National	DP8251	
8255	AMD	9555	
	National	DP8255	
8257	AMD	8257	
8259	AMD	8259	
8300	**National**	**DP8300**	**458**
8302	**National**	**DP8302**	**466**
8304	**National**	**DP8304**	**472**
8308	AMD	9208	
	EA	EA8308	
	Mostek	MK30000	
	TI	**TMS4700**	**856**
8316	AMD	8316	
	GI	RO3-8316	
	Mostek	MK34000	
	Synertek	SY2316	
8702	AMD	8702	
8708	Mostek	MK3708	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

IC MASTER

Intersil

Manufacturer Device	Replacement Source	Device	IC Master Page
AH0126	Siliconix	DG126	
AH0129	Siliconix	DG129	
AH0133	Siliconix	DG133	
AH0134	Siliconix	DG134	
AH0139	Siliconix	DG139	
AH0140	Siliconix	DG140	
AH0141	Siliconix	DG141	
AH0142	Siliconix	DG142	
AH0143	Siliconix	DG143	
AH0144	Siliconix	DG144	
AH0145	Siliconix	DG145	
AH0146	Siliconix	DG146	
AH0151	Siliconix	DG151	
AH0152	Siliconix	DG152	
AH0153	Siliconix	DG153	
AH0154	Siliconix	DG154	
AH0161	Siliconix	DG161	
AH0162	Siliconix	DG162	
AH0163	Siliconix	DG163	
AH0164	Siliconix	DG164	
DG111	Siliconix	DGM111	
DG116	Siliconix	DG116	
DG118	Siliconix	DG172	
DG123	Siliconix	DG123	
DG125	Siliconix	DG125	
DG126	Siliconix	DG126	
DG129	Siliconix	DG129	
DG133	Siliconix	DG133	
DG134	Siliconix	DG134	
DG139	Siliconix	DG139	
DG140	Siliconix	DG140	
DG141	Siliconix	DG141	
DG142	Siliconix	DG142	
DG143	Siliconix	DG143	
DG144	Siliconix	DG144	
DG145	Siliconix	DG145	
DG146	Siliconix	DG146	
DG151	Siliconix	DG151	
DG152	Siliconix	DG152	
DG153	Siliconix	DG153	
DG154	Siliconix	DG154	
DG161	Siliconix	DG161	
DG162	Siliconix	DG162	
DG163	Siliconix	DG163	
DG164	Siliconix	DG164	
DG182	Siliconix	DG182	
DG185	Siliconix	DG185	
DG188	Siliconix	DG188	
DG191	Siliconix	DG191	
DG426	Siliconix	DG126	
DG464	Siliconix	DG164	
D123	Siliconix	D123	
D125	Siliconix	D125	
G115	Siliconix	G115	
G116	Siliconix	G116	
G117	Siliconix	G117	
G118	Siliconix	G118	
G119	Siliconix	G119	
G123	Siliconix	G123	
G125	Siliconix	G125	
G126	Siliconix	G126	
G127	Siliconix	G127	
G128	Siliconix	G128	
G129	Siliconix	G129	
G130	Siliconix	G130	
G131	Siliconix	G131	
G132	Siliconix	G132	
IH5009	AMI	MX52	
	National	AH5009	
IH5010	AMI	MX52	
	National	AH5010	
IH5040	**Harris**	**HI5040**	**433**
IH5041	**Harris**	**HI5041**	**433**
IH5042	**Harris**	**HI5042**	**433**
IH5042	Siliconix	DG188	
IH5043	Siliconix	DG191	
IH5044	**Harris**	**HI5044**	**433**
IH5045	**Harris**	**HI5045**	**433**
	Siliconix	DG185	
IH5046	**Harris**	**HI5046**	**433**
IH5047	**Harris**	**HI5047**	**433**
IH5048	Siliconix	DG181	
IH5049	**Harris**	**HI5049**	**433**
	Siliconix	DG184	
IH5050	**Harris**	**HI5050**	**433**
	Siliconix	DG187	
IH5051	**Harris**	**HI5051**	**433**
	Siliconix	DG190	
IH5070	**AD**	**AD7507**	**431**
	Harris	**HI507**	**432**
	Siliconix	DG507	
IM55S08	TI	SN74S314	
IM55S18	TI	SN74S314	
IM5501	AMD	IM5501	
	MMI	5560	
		6560	
	Signetics	82S25	
	TI	SN54S289	
		SN74S289	
IM5502	TI	SN5481A	
IM5503	MMI	6531	
	Signetics	N82S17	
		74S301	
	TI	SN54S301	
		SN74S300	
		SN74S301	
IM5508	Fairchild	93415	
	Signetics	N82S10	
	TI	SN74S314	
IM5512	TI	SN5481A	
IM5523	Fairchild	93421	
	MMI	5531	
		6531	
	National	MM74S200	
	Raytheon	RC5340	
		RC5540	
		RM5340	
	Signetics	N82S16	
		S82S16	
	TI	SN54S201	
		SN74S201	
		SN74200A	
IM5533	Fairchild	93411	
	MMI	5530	
		6530	
	National	MM74S206	
	Raytheon	RC5330	
		RM5330	
	Signetics	N82S17	
	TI	SN54S301	
		SN74S300	
		SN74S301	
IM5543	Fairchild	93421	
	TI	SN54S301	
		SN54S475	**864**
		SN74S301	
		SN74S475	**864**
IM5553	Fairchild	93411	
IM5600	Harris	HPROM8256	
	MMI	5330	
		6330	
	National	**DM7577**	**702**
		DM8577	**702**
	Signetics	N82S23	
	TI	**SN54S188**	**860**
		SN74S188	**860**
IM5602	MMI	6340	
	TI	**SN54S475**	**864**
		SN74S475	**864**
IM5603	Fairchild	93416	
	Harris	HPROM1024A	
	Intel	M3601	
		3601	**695**
	MMI	5300	
		6300	
IM5603	NEC	μPB403	
	Signetics	82S126	
	TI	**SN54S387**	**861**
		SN74S387	**861**
IM5604	Fairchild	93436	
	Harris	**HM7620**	**682**
	Intel	**3602**	**697**
	MMI	5305	
		6305	
	National	**DM54S570**	**710**
		DM74S570	**710**
	Signetics	N82S130	
	TI	SN54S270	
		SN74S270	
IM5605	**Harris**	**HM7640**	**682**
	Intel	3604	
	MMI	5340	
		6340	
	National	**DM77S295**	**714**
		DM87S295	**714**
	TI	**SN54S475**	**864**
		SN74S475	**864**
IM5606	**National**	**DM54S572**	**702**
		DM54S572	**712**
		DM74S572	**702**
		DM74S572	**712**
IM5610	**Harris**	**HM7603**	**682**
	MMI	5331	
		6331	
	National	**DM7578**	**702**
		DM8578	**702**
	Signetics	N82S123	
	TI	SN54S288	
		SN74S288	
IM5623	Fairchild	93426	
	Harris	HPROM1024	
	Intel	**3621**	**695**
	MMI	5301	
		6301	
	Signetics	N82S129	
	TI	**SN54S287**	**861**
		SN74S287	**861**
IM5624	Fairchild	93446	
	Harris	**HM7621**	**682**
	Intel	**3622**	**697**
	MMI	5306	
		6306	
	National	**DM54S571**	**710**
		DM74S571	**710**
	Signetics	N82S131	
	TI	SN54S370	
		SN74S370	
IM5625	**Harris**	**HM7641**	**682**
	Intel	3624	
	MMI	5341	
		6341	
	National	**DM77S296**	**714**
		DM87S296	**714**
	TI	**SN54S474**	**864**
		SN74S474	**864**
IM5626	**National**	**DM54S573**	**702**
		DM54S573	**702**
		DM54S573	**712**
		DM74S573	**712**
IM6100	Harris	HM6100	
IM6100A	**Harris**	**HM6100A**	**966**
IM6100C	Harris	HM6100C	
IM6101	Harris	HD6101	
IM6101A	**Harris**	**HD6101A**	**982**
IM6101C	Harris	HD6101C	
IM6312	**Harris**	**HM6312**	**681**
IM6402	**Harris**	**HD6402**	**976**
IM6402A	Harris	HD6402A	
IM6402C	Harris	HD6402C	
IM6403	Harris	HM6403	
IM6403A	Harris	HD6403A	
IM6508	**Harris**	**HM6508**	**679**
IM6508C	**Harris**	**HM6508C**	**679**
IM6518	**Harris**	**HM6518**	**679**
IM6523	RCA	CD4061	
IM6524	Harris	HM6524	
IM6524-1	Harris	HM6524-1	
IM6551	**Harris**	**HM6551**	**676**
IM6561	**Harris**	**HM6561**	**677**
IM6900	Harris	HM6900	
IM7051	AMD	1101	
IM7501	Mostek	MK4007	
IM7511	Mostek	MK4007	
IM7512	Mostek	MK4007	
	Signetics	1101	
IM7552	Mostek	MK4102	
	SGS	M330	
	Signetics	2102	
	TI	TMS4033	
		TMS4034	
		TMS4035	
IM7702	Nortec	1402	
	Signetics	2502	
IM7703	Nortec	1403	
	Signetics	2503	
IM7704	Nortec	1404	
	Signetics	2504	
IM7712	AMD	AM2806	
	Nortec	2512	
	Signetics	2512	
	Synertek	SY7712	
IM7722	AMD	AM2808	
	Signetics	2525	
	Synertek	SY7722	
IM7780	Mostek	MK1007	
	Signetics	2532	
	Synertek	SY7780	
	TI	TMS3409	
MM452	Siliconix	SI452	
MM455	Siliconix	SI455	
MM552	Siliconix	SI552	
MM555	Siliconix	SI555	
SSS1458	RCA	CA1458	
	Silicon G	SG1458	
SSS1558	**AD**	**AD101**	**575**
	National	LM101	
	RCA	CA101	
		CA1558	
		CA748	
	Silicon G	SG1558	
	Teledyne S	LM101	
101	Motorola	MLM101	
	Silicon G	SG101	
105	Motorola	MLM105	
	Silicon G	SG105	
	Teledyne S	LM105	
107	Motorola	MLM107	
	RCA	CA107	
	Silicon G	SG107	
108	**AD**	**AD108**	**575**
	National	LM108	
	Raytheon	LM108	
	RCA	CA108	
	Silicon G	SG108	
111	Motorola	MLM111	
	RCA	CA111	
	Silicon G	SG111	
	Teledyne S	LM111	
201	**AD**	**AD201**	**575**
	Motorola	MLM201	
	National	LM201	
	RCA	CA201	
		CA748	
	Silicon G	SG201	
	Teledyne S	LM201	
205	Motorola	MLM205	
	Silicon G	SG205	
	Teledyne S	LM205	
207	Motorola	MLM207	
	RCA	CA207	
	Silicon G	SG207	
208	**AD**	**AD208**	**575**
	Motorola	MLM208	
	National	LM208	
	Raytheon	LM208	
	RCA	CA208	
	Silicon G	SG208	

♦ Discontinued

Bold face device numbers indicate manuracturers' data is provided in the IC Master on the pages noted.

Intersil (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
211	Motorola	MLM211	
	RCA	CA211	
	Silicon G	SG211	
	Teledyne S	LM211	
2650	Signetics	2650	
301	**AD**	**AD301**	**575**
	Motorola	MLM301	
	National	LM301	
	Raytheon	LM301	
	RCA	CA301	
	Silicon G	SG301	
	Teledyne S	LM301	
305	Motorola	MLM305	
	Silicon G	SG305	
	Teledyne S	LM305	
307	RCA	CA307	
	Silicon G	SG307	
308	**AD**	**AD308**	**575**
	Motorola	MLM308	
	National	LM308	
	Raytheon	LM308	
	RCA	CA308	
	Silicon G	SG308	
311	Motorola	MLM311	
	RCA	CA311	
	Silicon G	SG311	
	Teledyne S	LM311	
4250	National	LM4250	
	Silicon G	SG4250	
555	Lithic Sys	LS555	
	Motorola	MC1455	
	National	LM555	
	Raytheon	RC555	
		RM555	
	RCA	CA355	
	Silicon G	SG555	
7001	RCA	7001	
	TI	TMS7001	
7101	RCA	MW4101	
7111	RCA	MW4111	
7112	RCA	MW4112	
723	Motorola	MC1723	
	National	LM723	
	Raytheon	RC723	
		RM723	
	RCA	CA723	
	Silicon G	SG723	
	Teledyne S	723	
7270	**National**	**MM5270**	**783**
7271	**National**	**MM5271**	**791**
7280	National	MM7280	
	RCA	MW4060	
741	**AD**	**AD741**	**575**
	Fairchild	μA741	
	Motorola	MC1741	
	National	LM741	
	PMI	SSS741	
	Raytheon	RC741	
		RM741	
	RCA	CA741	
	Silicon G	SG741	
	Teledyne S	741	
747	Motorola	MC1747	
	RCA	CA747	
	Silicon G	SG747	
748	Fairchild	μA748	
	Motorola	MC1748	
	National	LM748	
	Raytheon	RC748	
		RM748	
	RCA	CA748	
	Silicon G	SG748	
	Teledyne S	748	
8007	AD	AD8007	
8013	**AD**	**AD530**	**576**
		AD533	**577**
8038	DDC	1453	
	Lithic Sys	LS8038	
8101	RCA	CA748	
8201	RCA	CA748	

ITT Semiconductors

Manufacturer Device	Replacement Source	Device	IC Master Page
ITT1330	Motorola	MC1330	
ITT1352	Motorola	MC1352	
ITT3064	Motorola	MC1364	
ITT3065	Motorola	MC1358	
ITT552	Sprague	ULN-2001	
ITT554	Sprague	ULN-2002	
ITT556	Sprague	ULN-2003	
ITT9000	Fairchild	9000	
	TI	SN29000	
ITT9001	Fairchild	9001	
	TI	SN29001	
ITT9002	Fairchild	9002	
	TI	SN29002	
ITT9003	Fairchild	9003	
	TI	SN29003	
ITT9004	Fairchild	9004	
ITT9005	Fairchild	9005	
	TI	SN29005	
ITT9006	Fairchild	9006	
ITT9007	Fairchild	9007	
	TI	SN29007	
ITT9008	Fairchild	9008	
	TI	SN29008	
ITT9009	Fairchild	9009	
	TI	SN29009	
ITT9014	Fairchild	9014	
ITT9015	Fairchild	9015	
ITT9016	Fairchild	9016	
	TI	SN29016	
ITT9017	Fairchild	9017	
ITT9022	Fairchild	9022	
ITT9024	Fairchild	9024	
	TI	SN29024	
ITT9033	Fairchild	9033	
ITT9093	Motorola	MC853	
		MC953	
	Raytheon	RM993	
	SW	SW705	
	TI	SN158093	
		SN159093	
ITT9094	Motorola	MC856	
		MC956	
	Raytheon	RM994	
	SW	SW708	
	TI	SN158094	
		SN159094	
ITT9097	Motorola	MC855	
		MC955	
	Raytheon	RM997	
	SW	SW709	
ITT9099	Motorola	MC852	
		MC952	
	Raytheon	RM999	
	SW	SW706	
	TI	SN158099	
		SN159099	
ITT930	Motorola	MC830	
		MC930	
	Raytheon	RM930	
	SW	SW930	
	TI	SN15830	
		SN15930	
ITT9300	AMD	9300	
	Fairchild	9300	
	TI	SN29300	
		SN39300	
ITT9301	AMD	9301	
	Fairchild	9301	
	TI	SN29301	
		SN39301	
ITT9304	AMD	9304	
	Fairchild	9304	
ITT9309	AMD	9309	
	Fairchild	9309	
	TI	SN29309	
ITT9309	TI	SN39309	
ITT931	Motorola	MC831	
		MC931	
	TI	SN15831	
		SN15931	
ITT9312	AMD	9312	
	Fairchild	9312	
	TI	SN29312	
		SN39312	
ITT9316	AMD	9316	
	Fairchild	9316	
	Raytheon	RM9316	
	TI	SN29316	
		SN39316	
ITT932	Motorola	MC832	
		MC932	
	Raytheon	RM932	
	SW	SW932	
	TI	SN15832	
		SN15932	
ITT933	Motorola	MC833	
		MC933	
	Raytheon	RM933	
	SW	SW933	
	TI	SN15833	
		SN15933	
ITT935	Motorola	MC840	
		MC940	
	Raytheon	RM935	
	TI	SN15835	
		SN15935	
ITT936	Motorola	MC936	
	Raytheon	RM936	
	SW	SW936	
	TI	SN15836	
		SN15936	
ITT937	Motorola	MC837	
		MC937	
	Raytheon	RM937	
	SW	SW937	
	TI	SN15837	
		SN15937	
ITT944	Motorola	MC844	
		MC944	
	Raytheon	RM944	
	SW	SW944	
	TI	SN15844	
		SN15944	
ITT945	Motorola	MC845	
		MC945	
	Raytheon	RM945	
	SW	SW945	
	TI	SN15845	
		SN15945	
ITT946	Motorola	MC846	
		MC946	
	Raytheon	RM946	
	SW	SW946	
	TI	SN15846	
		SN15946	
ITT948	Motorola	MC848	
		MC948	
	Raytheon	RM948	
	SW	SW948	
	TI	SN15848	
		SN15948	
ITT949	Motorola	MC849	
		MC949	
	Raytheon	RM949	
	SW	SW949	
	TI	SN15849	
		SN15949	
ITT950	Motorola	MC850	
		MC950	
	Raytheon	RM950	
	SW	SW950	
	TI	SN15850	
		SN15950	
ITT951	Motorola	MC851	
		MC951	
	Raytheon	RM951	
ITT951	SW	SW951	
	TI	SN15851	
		SN15951	
ITT9601	AMD	9601	
	Fairchild	9601	
	TI	SN29601	
ITT961	Motorola	MC861	
		MC961	
	Raytheon	RM961	
	SW	SW961	
	TI	SN15861	
		SN15961	
ITT962	Motorola	MC862	
		MC962	
	Raytheon	RM962	
	SW	SW962	
	TI	SN15862	
		SN15962	
ITT963	Motorola	MC1141	
		MC863	
		MC963	
	Raytheon	RM963	
	SW	SW963	
	TI	SN5481A	
		SN7481A	
SAA1024	SGS	M1024	
SAA1025	SGS	M1025	
TAA7756	NPC	SFC606	
TBA800	SGS	TBA800	
ZTK33	NPC	TAA550	

Lithic Systems

Manufacturer Device	Replacement Source	Device	IC Master Page
LA3018	Fairchild	μA3018	
		CA3018	
	National	LM3018	
	RCA	CA3018	
	Silicon G	SG3018	
LA3026	Fairchild	μA3026	
	RCA	CA3026	
	Silicon G	SG3822	
LA3045	Fairchild	μA3045	
	Plessey	SL3045	
	RCA	CA3045	
	Silicon G	SG3821	
LA3086	Fairchild	μA3086	
	Motorola	MC3386	
	Plessey	SL3086	
	RCA	CA3086	
	Silicon G	SG3886	
LS1495	Fairchild	μA795	
	Motorola	MC1495	
	Silicon G	SG1495	
LS1496	Fairchild	μA796	
	Motorola	MC1496	
	National	LM1496	
	Signetics	MC1496	
	Silicon G	SG1496	
LS1595	Fairchild	μA795	
	Motorola	MC1595	
	Silicon G	SG1595	
LS1596	Fairchild	μA796	
	Motorola	MC1596	
	National	LM1596	
	Signetics	MC1596	
	Silicon G	SG1596	
LS170	National	LM170	
LS171	National	LM171	
LS270	National	LM270	
LS271	National	LM271	
LS3028	National	LM3028	
	RCA	CA3028	
LS3053	National	LM3053	
	RCA	CA3053	
LS370	National	LM370	
LS371	National	LM371	
LS555	Exar	XR555	
	Intersil	NE555	
	Motorola	MC1455	
	National	LM555	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

IC MASTER

Lithic Systems (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
LS555	Raytheon	RC555	
	Signetics	NE555	
	Silicon G	SG555	
	TI	SN72555	
LS8038	Intersil	8038	

Micro Networks

Manufacturer Device	Replacement Source	Device	IC Master Page
DAC80	Beckman	877-80	
	Burr-Brown	DAC80	
	Datel	DAC-HZ12B	
DAC85	Beckman	877-85	

Monolithic Memories, Inc.

Manufacturer Device	Replacement Source	Device	IC Master Page
♦A5280	AMD	AM27S80	
♦A5281	AMD	AM27S81	
♦A6280	AMD	AM27S80	
♦A6281	AMD	AM27S81	
♦H5200	Intel	33011	
	TI	SN187	
♦H5201	**TI**	**SN54S287**	**861**
♦H6200	Intel	3301	
♦H6201	**TI**	**SN74S287**	**861**
♦L5560	AMD	31L01	
	National	DM54LS289	
		DM54L89A	
♦L6561	**National**	**DM74S189**	**746**
5200	Fairchild	93416	
	Intel	3301	
	Intersil	IM5603	
	Signetics	82S226	
	TI	SN54187	
5201	Intersil	IM5623	
	Signetics	82S299	
	TI	**SN54S387**	**861**
5205	Intersil	IM5604	
	TI	SN54S270	
5206	TI	SN54S370	
5230	Intersil	IM5600	
	National	**DM5488**	**702**
	TI	SN5488A	
5231	Intersil	IM5610	
	TI	**SN54S188**	**860**
5300	Fairchild	93416	
	Harris	HPROM1024A	
	Intel	M3601	
	Intersil	IM5603	
	Signetics	82S126	
	TI	**SN54S387**	**861**
5301	Harris	HPROM1024	
	Intersil	IM5623	
	Signetics	82S129	
	TI	**SN54S287**	**861**
5305	Fairchild	93436	
	Harris	**HM7620**	**682**
	Intersil	IM5604	
	National	**DM54S571**	**710**
	Signetics	82S130	
	TI	SN54S270	
5306	Fairchild	93446	
	Harris	**HM7621**	**682**
	Intersil	IM5624	
	National	**DM54S571**	**710**
	Signetics	S82S131	
	TI	SN54S370	
5330	AMD	AM27S08	
	Harris	HPROM8256	
	Intersil	IM5533	
		IM5600	
	National	**DM7577**	**702**
	Signetics	82S23	
	TI	**SN54S188**	**860**
5331	**Harris**	**HM7603**	**682**
	Intersil	IM5610	
	National	**DM7578**	**702**
5331	Signetics	82S123	
	TI	SN54S288	
5340	**Harris**	**HM7640**	**682**
	Intel	M3604	
	National	**DM77S296**	**714**
	TI	**SN54S475**	**864**
5341	**Harris**	**HM7641**	**682**
	Intel	M3624	
	National	**DM77S296**	**714**
	TI	**SN54S474**	**864**
		SN54S474	**864**
5352	**National**	**DM54S572**	**702**
		DM54S572	**712**
5353	**Harris**	**HM7642**	**682**
	National	**DM54S573**	**702**
		DM54S573	**702**
		DM54S573	**712**
5530	Fairchild	93411	
	National	**DM54S206**	**751**
	Raytheon	RM5330	
	Signetics	82S17	
	TI	SN54S301	
5531	Fairchild	93421	
	Intersil	IM5523	
	National	**DM54S200**	**704**
	Raytheon	RM5340	
	Signetics	82S16	
	TI	SN54S201	
5560	AMD	AM27S02	
	Fairchild	93435	
	Intersil	IM5501	
	National	DM54S289	
		DM5489	**704**
		DM5489	**741**
	TI	SN54S289	
5561	AMD	AM27S03	
	National	**DM54S189**	**746**
	TI	SN54S189	
6200	Intersil	IM5603	
	Signetics	82S226	
	TI	SN74187	
6201	Intersil	IM5623	
	National	**DM85S97**	**702**
	Signetics	82S229	
	TI	**SN74S387**	**861**
6205	Intersil	IM5604	
	Signetics	82S230	
	TI	SN74S270	
6206	Signetics	82S231	
	TI	SN74S370	
6230	Intersil	IM5600	
	Motorola	MCM4002	
	National	**DM7488**	**702**
	Signetics	8223	
	TI	SN7488A	
6231	**National**	**DM8598**	**702**
6246	Signetics	N8204	
6247	Signetics	N8205	
6300	Fairchild	93416	
	Harris	HPROM1024A	
	Intel	**3601**	**695**
	Intersil	IM5603	
	Signetics	82S126	
	TI	**SN74S387**	**861**
6301	Fairchild	93426	
	Harris	HPROM1024	
	Intel	**3621**	**695**
	Intersil	IM5623	
	Signetics	82S129	
	TI	**SN74S287**	**861**
6305	Fairchild	93436	
	Harris	**HM7620**	**682**
		HM7620	**682**
	Intel	**3602**	**697**
	Intersil	IM5604	
	National	**DM74S571**	**710**
	Signetics	82S130	
	TI	SN74S270	
6306	Fairchild	93446	
	Harris	**HM7621**	**682**
	Intel	**3622**	**697**
6306	**National**	**DM74S571**	**710**
	Signetics	82S131	
	TI	SN74S370	
6330	AMD	AM27S08	
	Harris	HPROM8256	
	Intersil	IM5600	
	National	**DM8577**	**702**
	Signetics	82S23	
	TI	SN74188A	
6331	AMD	AM27S09	
	Harris	**HM7603**	**682**
	Intersil	IM5610	
	National	**DM8578**	**702**
	Signetics	82S123	
	TI	SN74S288	
6335	Fairchild	93436	
	Intel	**3602**	**697**
6340	**Harris**	**HM7640**	**682**
	Intel	3604	
	Intersil	IM5605	
	National	**DM87S296**	**714**
	TI	**SN74S475**	**864**
6341	**Harris**	**HM7641**	**682**
	Intel	3624	
	Intersil	IM5625	
	National	**DM87S295**	**714**
		DM87S296	**714**
	TI	**SN74S474**	**864**
6352	**Intel**	**3605**	**699**
	National	**DM74S572**	**702**
		DM74S572	**712**
6353	**Harris**	**HM7642**	**682**
	Intel	**3625**	**699**
6530	Fairchild	93411	
	Intel	3107	
	Intersil	IM5533	
	National	**DM74S206**	**751**
	Raytheon	RC5330	
	Signetics	82S17	
	TI	SN74S301	
6531	Fairchild	93421	
	Intel	3106	
	Intersil	IM5523	
	National	**DM74S200**	**704**
	Signetics	82S16	
	TI	SN74S201	
6560	AMD	AM27S02	
		MM6560	
	Fairchild	93435	
	Intel	3101	
	Intersil	IM5501	
	National	DM74S289	
	Signetics	3101A	
		82S25	
	TI	SN74S289	
6561	AMD	AM27S03	
		MM6561	
	National	**DM74S189**	**746**
	TI	SN74S189	

MOS Technology

Manufacturer Device	Replacement Source	Device	IC Master Page
MCS6502	Synertek	SY6502	
MCS6503	Synertek	SY6503	
MCS6504	Synertek	SY6504	
MCS6505	Synertek	SY6505	
MCS6520	Synertek	SY6520	
MCS6522	Synertek	SY6522	
MCS6530	Synertek	SY6530	
MCS6532	Synertek	SY6532	

Mostek

Manufacturer Device	Replacement Source	Device	IC Master Page
F8	**Fairchild**	**F8**	**953**
		F8	**957**
MK1002	AMD	1002	
	SGS	M142	
MK1007	Intersil	IM7780	
	SGS	M142	
MK1007	Signetics	2532	
	TI	TMS3409	
MK2300	TI	TMS2300	
MK2302	GI	RO5-2240S	
MK2400	AMI	S8773	
MK2500	**AMI**	**S5232**	**650**
MK3880	Zilog	Z80-CPU	
MK3881	Zilog	Z80-PIO	
MK3882	Zilog	Z80-CTC	
MK3883	Zilog	Z80-DMA	
MK3884	Zilog	Z80-SIO	
MK4006	**AMI**	**S4006**	**634**
	Motorola	MCM4006	
	TI	**SN74S387**	**861**
MK4007	Intersil	IM7501	
		IM7511	
MK4008	**AMI**	**S4008**	**634**
MK4027	Fairchild	FM4027	
	RCA	MW4104	
MK4096	EA	EA4096	
	EMM/Semi	RO3-4096	
	Fairchild	4096	
	Rockwell	1604	
	Western	RM4096	
MK4102	Intersil	IM7552	
	SGS	M330	
	Signetics	2102	
	TI	TMS4033	
		TMS4035	
MK50240	GI	AY3-0215	
MK50241	GI	AY3-0216	
MK50242	GI	AY1-0212	
		AY3-0214	
3850	**Fairchild**	**3850**	**954**
3851	**Fairchild**	**3851**	**954**
3852	**Fairchild**	**3852**	**956**
3853	**Fairchild**	**3853**	**956**
3854	**Fairchild**	**3854**	**956**

Motorola Semiconductor

Manufacturer Device	Replacement Source	Device	IC Master Page
LF355	Fairchild	μAF355	
LF356	Fairchild	μAF356	
LF357	Fairchild	μAF357	
LM317	National	LM317	
LM323	National	LM323	
MCM10140	Plessey	SP10140	
	Signetics	10140	
	TI	SN10140	
MCM10142	NEC	μPB10142	
	Plessey	SP10142	
	TI	SN10142	
MCM10144	Fairchild	F10410	
	Plessey	SP10144	
	Raytheon	RC10144	
	Signetics	10144	
	TI	SN10144	
MCM10145	Hitachi	MD10145	
	Plessey	SP10145	
	Signetics	10145	
	TI	SN10145	
MCM10147	Fairchild	F10405	
	TI	SN10147	
MCM10148	Plessey	SP10148	
	Signetics	10148	
	TI	SN10147	
		SN10148	
MCM10149	Signetics	10149	
MCM1110	National	MM5231	
	Signetics	2430	
	TI	TMS2600	
♦MCM1112	National	MM4230	
		MM5230	
♦MCM1131	AMI	S8614	
♦MCM1132	AMI	S8614	
	TI	TMS4103	
MCM1140	TI	TMS4300	
♦MCM1173	AMI	S2103	
MCM14537	RCA	CD4061	
♦MCM2102	Mostek	MK4102	

♦ Discontinued

Bold face device numbers indicate manuracturers' data is provided in the IC Master on the pages noted.

Motorola Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
MCM4002	Intersil	IM5600	
	MMI	6230	
	National	**DM5488**	**702**
		DM7488	**702**
	TI	SN7488	
MCM4004	Fairchild	93407	
	Intersil	IM5603	
	MMI	6200	
	TI	SN7481A	
MCM4005	Fairchild	93407	
	TI	SN7481A	
MCM4006	**TI**	**SN74S387**	**861**
MCM4064	Fairchild	93403	
	Intersil	IM5501	
♦MCM4065	Signetics	8225	
♦MCM4256	Intersil	IM5523	
MCM5303	Harris	HPROM0512	
MCM6560	Nitron	NCM6560	
MCM6561	Nitron	NCM6561	
MCM6570	Nitron	NCM6570	
MCM6571	Nitron	NCM6571	
MCM6572	Nitron	NCM6572	
MCM6580	Nitron	NCM6580	
MCM6581	Nitron	NCM6581	
MCM6583	Nitron	NCM6583	
MCM6590	Nitron	NCM6590	
MCM6591	Nitron	NCM6591	
MCM6604	Mostek	MK4096	
	RCA	MW4104	
MCM6605	Intersil	IM7505	
MCM6616	Mostek	MK4116	
MCM6810	**AMI**	**S6810**	**649**
		S6810	**889**
		S6810	**916**
MCM6830	**AMI**	**S6830**	**659**
		S6830	**889**
		S6830	**925**
MCM68317	Mostek	MK34000	
MCM6832	Nitron	NCM6832	
♦MCM7001	RCA	MW7001	
	TI	TMS7001	
MC10100	Plessey	SP10100	
MC10101	Fairchild	F10101	
	Plessey	SP10101	
	Signetics	10101	
MC10102	Fairchild	F10102	
	Plessey	SP10102	
	Signetics	10102	
MC10103	Fairchild	F10103	
	Plessey	SP10103	
	Signetics	10103	
MC10104	Fairchild	F10104	
	Plessey	SP10104	
	Signetics	10104	
MC10105	Fairchild	F10105	
	Plessey	SP10105	
	Signetics	10105	
MC10106	Fairchild	F10106	
	Plessey	SP10106	
	Signetics	10106	
MC10107	Fairchild	F10107	
	Plessey	SP10107	
	Signetics	10107	
MC10109	Fairchild	F10109	
	Plessey	SP10109	
	Signetics	10109	
MC10110	Fairchild	F10110	
	Plessey	SP10110	
	Signetics	10110	
MC10111	Fairchild	F10111	
	Plessey	SP10111	
	Signetics	10111	
MC10113	Fairchild	F10113	
	Plessey	SP10113	
	Signetics	10113	
MC10114	Fairchild	F10114	
	Plessey	SP10114	
MC10114	Signetics	10114	
MC10115	Plessey	SP10115	
	Signetics	10115	
MC10116	Fairchild	F10116	
	Plessey	SP10116	
	Signetics	10116	
MC10117	Fairchild	F10117	
	Plessey	SP10117	
	Signetics	10117	
MC10118	Fairchild	F10118	
	Plessey	SP10118	
	Signetics	10118	
MC10119	Fairchild	F10119	
	Plessey	SP10119	
	Signetics	10119	
MC10121	Fairchild	F10121	
	Plessey	SP10121	
	Signetics	10121	
MC10123	Fairchild	F10123	
	Signetics	10123	
MC10124	Fairchild	F10124	
	Plessey	SP10124	
	Signetics	10124	
MC10125	Fairchild	F10125	
	Plessey	SP10125	
	Signetics	10125	
MC10128	Plessey	SP10128	
	Signetics	10128	
MC10129	Plessey	SP10129	
	Signetics	10129	
MC10130	Fairchild	F10130	
	Plessey	SP10130	
	Signetics	10130	
MC10131	Fairchild	F10131	
	Plessey	SP10131	
	Signetics	10131	
MC10132	Fairchild	F10132	
	Signetics	10132	
MC10133	Fairchild	F10133	
	Signetics	10133	
MC10134	Fairchild	F10134	
	Plessey	SP10134	
	Signetics	10134	
MC10135	Fairchild	F10135	
	Plessey	SP10135	
	Signetics	10135	
MC10136	Fairchild	F10136	
	Plessey	SP10136	
	Signetics	10136	
MC10137	Fairchild	F10137	
	Plessey	SP10137	
	Signetics	10137	
MC10138	Plessey	SP10138	
	Signetics	10138	
MC10139	Intersil	IM5600	
	Signetics	10139	
MC10141	Fairchild	F10141	
	Plessey	SP10141	
	Signetics	10141	
MC10153	Fairchild	F10153	
MC10158	Fairchild	F10158	
MC10160	Plessey	SP10160	
	Signetics	10160	
MC10161	Fairchild	F10161	
	Signetics	10161	
MC10162	Fairchild	F10162	
	Plessey	SP10162	
	Signetics	10162	
MC10164	Plessey	SP10164	
	Signetics	10164	
MC10165	Plessey	SP10165	
MC10166	Fairchild	F10166	
MC10168	Fairchild	F10168	
MC10170	Fairchild	F10170	
	Signetics	10170	
MC10171	Fairchild	F10171	
	Plessey	SP10171	
	Signetics	10171	
MC10172	Fairchild	F10172	
	Plessey	SP10172	
	Signetics	10172	
MC10173	Fairchild	F10173	
	Plessey	SP10173	
	Signetics	10173	
MC10174	Plessey	SP10174	
	Signetics	10174	
MC10175	Fairchild	F10175	
	Plessey	SP10175	
	Signetics	10175	
MC10176	Fairchild	F10176	
	Plessey	SP10176	
	Signetics	10176	
MC10178	Fairchild	F10178	
	Plessey	SP10178	
	Signetics	10178	
MC10179	Fairchild	F10179	
	Plessey	SP10179	
	Signetics	10179	
MC10180	Fairchild	F10180	
	Plessey	SP10180	
	Signetics	10180	
MC10181	Fairchild	F10181	
	Plessey	SP10181	
	Signetics	10181	
MC10186	Fairchild	F10186	
	Signetics	10186	
MC10190	Signetics	10190	
MC10191	Signetics	10191	
MC10192	Fairchild	F10192	
	Signetics	10192	
MC10195	Signetics	10195	
MC10210	Plessey	SP10210	
MC10216	Plessey	SP10216	
	Signetics	10216	
MC10231	Plessey	SP10231	
	Signetics	10231	
MC10501	Plessey	SP10501	
MC10502	Plessey	SP10502	
MC10504	Plessey	SP10504	
MC10505	Plessey	SP10505	
MC10506	Plessey	SP10506	
MC10507	Plessey	SP10507	
MC10509	Plessey	SP10509	
MC10514	Plessey	SP10514	
MC10515	Plessey	SP10515	
MC10516	Plessey	SP10516	
MC10517	Plessey	SP10517	
MC10518	Plessey	SP10518	
MC10519	Plessey	SP10519	
MC10521	Plessey	SP10521	
MC10524	Plessey	SP10524	
MC10525	Plessey	SP10525	
MC10531	Plessey	SP10531	
♦MC1150	AMI	MX53D	
♦MC1160	TI	TMS3003	
♦MC1161	TI	TMS4062	
♦MC1180	AMI	S2470	
♦MC1181	AMI	S2567	
	Nitron	NC1181	
♦MC1182	AMI	S2566	
	Nitron	NC1182	
♦MC1183	AMI	S2555	
	Nitron	NC1183	
♦MC1184	AMI	S2556	
	Nitron	NC1184	
MC1303	Raytheon	RC4739	
♦MC1304	Fairchild	μA732	
	National	LM1304	
	Sprague	ULN-2120	
♦MC1305	National	LM1305	
	Sprague	ULN-2122	
♦MC1307	Fairchild	μA767	
	National	LM1307	
	Sprague	ULN-2128	
MC1310	Exar	XR1310	
	RCA	CA1310	
	Sprague	ULN-2211	
♦MC1311	Exar	XR1800	
	Fairchild	μA758	
	RCA	CA758	
	Sprague	ULN-2244	
MC1312	Fairchild	μA1312	
MC1324	Sprague	ULN-2224	
♦MC1328	RCA	CA3072	
	Sprague	ULN-2114	
		ULN-2228	
♦MC1339	Signetics	PA239	
	Sprague	ULN-2126	
MC1350	NPC	ESM1350	
MC1351	National	LM1351	
MC1352	RCA	CA1352	
MC1356	Sprague	ULN-2136	
MC1357	Fairchild	μA2136	
	RCA	CA2111	
	Signetics	ULN2111	
	Sprague	ULN-2111	
		ULN-2113	
MC1358	Fairchild	μA3065	
	RCA	CA3065	
	Sprague	ULN-2165	
MC1364	Fairchild	μA3064	
	Sprague	ULN-2264	
♦MC1370	Fairchild	μA780	
	Sprague	ULN-2124	
♦MC1371	Fairchild	μA781	
	Sprague	ULN-2127	
MC1375	Sprague	ULN-2129	
MC1391	Fairchild	μA1391	
	Sprague	ULN-2291	
MC1394	Fairchild	μA1394	
MC1398	RCA	CA1398	
	Sprague	ULN-2298	
MC14000	Harris	HD4000	
	National	CD4000	
	RCA	CD4000	
	SSS	SCL4000	
	TI	TP4000	
MC14001	Fairchild	F4001	
	GI	MEM4001	
	Harris	HD4001	
	National	CD4001	
	RCA	CD4001	
	SGS	HBF4001	
	SSS	SCL4001	
	SW	SW4001	
	TI	TP4001	
	Toshiba	TC4001	
MC14002	Fairchild	F4002	
	Harris	HD4002	
	National	CD4002	
	RCA	CD4002	
	SGS	HBF4002	
	SSS	SCL4002	
	TI	TP4002	
	Toshiba	TC4002	
MC14006	Fairchild	F4006	
	Harris	HD4006	
	National	CD4006	
	RCA	CD4006	
	SSS	SCL4006	
MC14007	Fairchild	F4007	
	GI	MEM4007	
	National	CD4007	
	RCA	CD4007	
	SGS	HBF4007	
	SSS	SCL4007	
	TI	TP4007	
	Toshiba	TC4007	
MC14008	Fairchild	F4008	
	Harris	HD4008	
	National	CD4008	
	RCA	CD4008	
	SSS	SCL4008	
	TI	TP4008	
	Toshiba	TC4008	
MC14009	National	CD4009	
	RCA	CD4009	
	SSS	SCL4009	
MC14010	National	CD4010	
	RCA	CD4010	
	SSS	SCL4010	
MC14011	Fairchild	F4011	
	GI	MEM4011	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Motorola Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Replacement Device	IC Master Page
MC14011	Harris	HD4011	
	National	CD4011	
	RCA	CD4011	
	SGS	HBF4011	
	SSS	SCL4011	
	SW	SW4011	
	TI	TP4011	
	Toshiba	TC4011	
MC14012	Fairchild	F4012	
	Harris	HD4012	
	National	CD4012	
	RCA	CD4012	
	SGS	HBF4012	
	SSS	SCL4012	
	SW	SW4012	
	TI	TP4012	
	Toshiba	TC4012	
MC14013	Fairchild	F4013	
	GI	MEM4013	
	Harris	HD4013	
	National	CD4013	
	RCA	CD4013	
	SGS	HBF4013	
	SSS	SCL4013	
	SW	SW4013	
	TI	TP4013	
	Toshiba	TC4013	
MC14014	National	CD4014	
	RCA	CD4014	
	SSS	SCL4014	
	TI	TP4014	
MC14015	Fairchild	F4015	
	Harris	HD4015	
	RCA	CD4015	
	SGS	HBF4015	
	SSS	SCL4015	
	SW	SW4015	
	TI	TP4015	
	Toshiba	TC4015	
MC14016	National	CD4016	
	RCA	CD4016	
	SSS	SCL4016	
	TI	TP4016	
MC14017	Fairchild	F4017	
	Harris	HD4017	
	National	CD4017	
	RCA	CD4017	
	SGS	HBF4017	
	SSS	SCL4017	
	SW	SW4017	
	TI	TP4017	
	Toshiba	TC4017	
MC14018	TI	TP4018	
MC14020	Fairchild	F4020	
	Harris	HD4020	
	National	CD4020	
	RCA	CD4020	
	SGS	HBF4020	
	SSS	SCL4020	
	SW	SW4020	
	TI	TP4020	
	Toshiba	TC4020	
MC14021	Fairchild	F4021	
	Harris	HD4021	
	National	CD4021	
	RCA	CD4021	
	SSS	SCL4021	
	SW	SW4021	
	TI	TP4021	
	Toshiba	TC4021	
MC14022	Fairchild	F4022	
	Harris	HD4022	
	National	CD4022	
	RCA	CD4022	
	SGS	HBF4022	
	SSS	SCL4022	
	TI	TP4022	
MC14022	Toshiba	TC4022	
MC14023	Fairchild	F4023	
	Harris	HD4023	
	National	CD4023	
	RCA	CD4023	
	SGS	HBF4023	
	SSS	SCL4023	
	SW	SW4023	
	TI	TP4023	
	Toshiba	TC4023	
MC14024	Fairchild	F4024	
	Harris	HD4024	
	National	CD4024	
	RCA	CD4024	
	SGS	HBF4024	
	SSS	SCL4024	
	SW	SW4024	
	TI	TP4024	
	Toshiba	TC4024	
MC14025	Fairchild	F4025	
	Harris	HD4025	
	National	CD4025	
	RCA	CD4025	
	SGS	HBF4025	
	SSS	SCL4025	
	SW	SW4025	
	TI	TP4025	
	Toshiba	TC4025	
MC14027	Fairchild	F4027	
	Harris	HD4027	
	National	CD4027	
	RCA	CD4027	
	SGS	HBF4027	
	SSS	SCL4027	
	SW	SW4027	
	TI	TP4027	
	Toshiba	TC4027	
MC14028	Fairchild	F4028	
	Harris	HD4028	
	National	CD4028	
	RCA	CD4028	
	SGS	HBF4028	
	SSS	SCL4028	
	SW	SW4028	
	TI	TP4028	
	Toshiba	TC4028	
MC14032	RCA	CD4032	
	Toshiba	TC4032	
MC14034	Fairchild	F4034	
	RCA	CD4034	
	SSS	SCL4034	
	Toshiba	TC4034	
MC14035	Fairchild	F4035	
	Harris	HD4035	
	National	CD4035	
	RCA	CD4035	
	SGS	HBF4035	
	SSS	SCL4035	
	TI	TP4035	
	Toshiba	TC4035	
MC14038	RCA	CD4038	
	Toshiba	TC4038	
MC14040	Fairchild	F4040	
	Harris	HD4040	
	National	CD4040	
	RCA	CD4040	
	SSS	SCL4040	
	TI	TP4040	
	Toshiba	TC4040	
MC14042	Fairchild	F4042	
	Harris	HD4042	
	National	CD4042	
	RCA	CD4042	
	SGS	HBF4042	
	SSS	SCL4042	
	TI	TP4042	
	Toshiba	TC4042	
MC14043	TI	TP4043	
MC14044	RCA	CD4044	
	SSS	SCL4044	
	TI	TP4044	
MC14046	Fairchild	F4046	
	RCA	CD4046	
	SSS	SCL4046	
		SCL4046	
MC14049	Fairchild	F4049	
	GI	MEM4049	
	Harris	HD4049	
	National	CD4049	
	RCA	CD4009	
		CD4049	
	SGS	HBF4049	
	SSS	SCL4049	
	SW	SW4049	
	TI	TP4049	
	Toshiba	TC4049	
MC14050	Fairchild	F4050	
	Harris	HD4050	
	National	CD4050	
	RCA	CD4010	
		CD4050	
	SGS	HBF4050	
	SSS	SCL4050	
	SW	SW4050	
	TI	TP4050	
	Toshiba	TC4050	
MC14051	RCA	CD4051	
	SSS	SCL4051	
	TI	TP4051	
MC14052	RCA	CD4052	
	SSS	SCL4052	
	TI	TP4052	
MC14053	RCA	CD4053	
	SSS	SCL4053	
	TI	TP4053	
MC14066	RCA	CD4066	
	SSS	SCL4066	
MC14068	Fairchild	F4068	
	RCA	CD4068	
	SSS	SCL4068	
	TI	TP4068	
	Toshiba	TC4068	
MC14069	Fairchild	F4069	
	National	CD4069	
	RCA	CD4069	
	SSS	SCL4069	
	TI	TP4069	
	Toshiba	TC4069	
MC14070	RCA	CD4070	
	SSS	SCL4070	
MC14071	Fairchild	F4071	
	RCA	CD4071	
	SSS	SCL4071	
	TI	TP4071	
	Toshiba	TC4071	
MC14072	RCA	CD4072	
	SSS	SCL4072	
	TI	TP4072	
MC14073	RCA	CD4073	
	SSS	SCL4073	
	TI	TP4073	
	Toshiba	TC4073	
MC14075	RCA	CD4075	
	SSS	SCL4075	
	TI	TP4075	
MC14076	Fairchild	F4076	
	Harris	HD4076	
	National	CD4076	
	RCA	CD4076	
	SSS	SCL4076	
MC14077	RCA	CD4077	
	SSS	SCL4077	
MC14078	RCA	CD4078	
	SSS	SCL4078	
	TI	TP4078	
MC1408	**AD**	**AD559**	**416**
	AMD	SSS1408	
	Datel	DAC-IC8BC	
	PMI	SSS1408	
	Signetics	MC1408	
MC14081	Fairchild	F4081	
	Harris	HD4081	
MC14081	RCA	CD4081	
	SSS	SCL4081	
	TI	TP4081	
	Toshiba	TC4081	
MC14082	RCA	CD4082	
	SSS	SCL4082	
	TI	TP4082	
MC1411	Sprague	ULN-2001	
MC1412	Sprague	ULN-2002	
MC1413	Sprague	ULN-2003	
MC1414	National	LM1414	
	Raytheon	RC1414	
	TI	TL514	
MC14160	Fairchild	F40160	
	SSS	SCL4160	
	TI	TP4360	
MC14161	Fairchild	F40161	
	SSS	SCL4161	
	TI	TP4361	
MC14162	Fairchild	F40162	
	SSS	SCL4162	
	TI	TP4362	
MC14163	Fairchild	F40163	
	SSS	SCL4163	
	TI	TP4363	
MC14174	Fairchild	F40174	
MC14194	Fairchild	F40194	
MC1436	**Harris**	**HA-2645**	**580**
	National	LM1436	
	Silicon G	SG1436	
MC1437	Raytheon	RC1437	
MC1441	RCA	CA1541	
MC14501	RCA	CD4068	
MC14502	RCA	CD4502	
	SSS	SCL4502	
MC14503	Harris	HD14503	
MC14506	RCA	CD4085	
MC14507	National	CD4070	
		MM74C86	
	RCA	CD4030	
		CD4070A	
	SSS	SCL4030	
	TI	TP4507	
MC14508	RCA	CD4508	
	Solitron	CM4508	
	SSS	SCL4508	
	Toshiba	TC4508	
MC14510	Fairchild	F4510	
	Harris	HD14510	
	National	CD4510	
	RCA	CD40192	
		CD4029	
		CD4510	
	SSS	SCL4510	
MC14511	Fairchild	F4511	
	Harris	HD14511	
	National	CD4511	
	RCA	CD4511	
	Solitron	CM4511	
	SSS	SCL4511	
	TI	TP4511	
MC14512	Fairchild	F4512	
	Harris	HD14512	
	SSS	SCL4512	
	TI	TP4512	
	Toshiba	TC4512	
MC14514	Fairchild	F4514	
	Harris	HD14514	
	Mitel	SIL4514	
	RCA	CD4514	
	Solitron	CM4514	
	SSS	SCL4514	
	Toshiba	TC4514	
MC14515	Fairchild	F4515	
	Harris	HD14515	
	RCA	CD4515	
	Solitron	CM4515	
	SSS	SCL4515	
	Toshiba	TC4515	
MC14516	Fairchild	F4516	
	National	CD4516	

♦ Discontinued

Bold face device numbers indicate manuracturers' data is provided in the IC Master on the pages noted.

Motorola Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
MC14516	RCA	CD40193	
		CD4516	
	SSS	SCL4516	
	Toshiba	TC4516	
MC14517	SSS	SCL4517	
MC14518	Fairchild	F4518	
	Harris	HD14518	
	National	CD4518	
	RCA	CD4518	
	Solitron	CM4518	
	SSS	SCL4518	
	TI	TP4518	
	Toshiba	TC4518	
MC14519	Fairchild	F4519	
	Harris	HD14519	
	RCA	CD4019	
	TI	TP4519	
MC14520	Fairchild	F4520	
	Harris	HD14520	
	National	CD4520	
	RCA	CD4520	
	Solitron	CM4520	
	SSS	SCL4520	
	TI	TP4520	
	Toshiba	TC4520	
MC14521	RCA	CD4045	
MC14522	Fairchild	F4522	
	Harris	HD14522	
	RCA	CD4018	
	SSS	SCL4522	
	TI	TP4522	
MC14525	RCA	CD4089	
MC14526	Fairchild	F4526	
	Harris	HD14526	
	SSS	SCL4526	
	TI	TP4526	
MC14527	Harris	HD14527	
	RCA	CD4527	
	SSS	SCL4527	
MC14528	Fairchild	F4528	
	Harris	HD14528	
	RCA	CD4528	
	Signetics	N4528	
	SSS	SCL4528	
	Toshiba	TC4528	
MC14529	Harris	HD14529	
	RCA	CD4067	
MC14531	Fairchild	F4531	
	RCA	CD40101	
	SSS	SCL4531	
	TI	TP4531	
MC14532	Fairchild	F4532	
	RCA	CD4532	
	Toshiba	TC4532	
MC14539	Fairchild	F4539	
	Toshiba	TC4539	
MC14543	Harris	HD14543	
	RCA	CD4056	
	SSS	SCL4543	
MC1455	Exar	XR555	
	Fairchild	μA555	
	Raytheon	RC555	
	RCA	CA555	
	Signetics	NE555	
MC14553	Fairchild	F4553	
MC14555	Fairchild	F4555	
	RCA	CD4555	
	SSS	SCL4555	
MC14556	Fairchild	F4556	
	RCA	CD4556	
	SSS	SCL4556	
MC14557	RCA	CD4031	
MC14558	Harris	HD14558	
	RCA	CD4055	
MC1456	**Harris**	**HA-2605**	**580**
	Raytheon	RC1556	
	Signetics	MC1456	
MC1456	Silicon G	SG1456	
MC14562	RCA	CD4062	
MC14569	RCA	CD4059	
MC14572	RCA	CD4069	
MC1458	Fairchild	μA1458	
	Harris	**HA-2655**	**580**
	National	LM1458	
	PMI	OP-04	
		SSS1458	
	Raytheon	RC1458	
		RC4558	
	RCA	CA1458	
	Signetics	MC1458	
	Silicon G	SG1458	
	Teledyne S	1458	
	TI	MC1458	
MC14580	RCA	CD40108	
MC14581	RCA	CD40181	
		CD4057	
	SSS	SCL4581	
	TI	TP4581	
MC14582	Fairchild	F4582	
	RCA	CD40182	
	SSS	SCL4582	
	TI	TP4582	
MC14583	RCA	CD40100	
	Toshiba	TC4583	
MC14584	Harris	HD14584	
	RCA	CD4016	
MC14585	Harris	HD14585	
	National	MM74C85	
	RCA	CD4063	
	SSS	HD14585	
		SCL4585	
	Toshiba	TC4585	
MC1468	Exar	XR1468	
	Silicon G	SG1468	
MC1488	AMD	MC1488	
	Exar	XR1488	
	ITT	ITT1488	
	National	DS1488	
	Raytheon	RC1488	
		RM1488	
	Silicon G	SG1488	
	TI	SN75188	
MC1489	AMD	MC1489	
	Exar	XR1489	
	ITT	ITT1489	
	National	DS1489	
	Raytheon	RC1489	
	Signetics	MC1489	
	Silicon G	SG1489	
	TI	SN75189	
MC1495	Intech	8495	
	Lithic Sys	LS1495	
	Silicon G	SG1495	
MC1496	Fairchild	μA796	
	Lithic Sys	LS1496	
	Signetics	MC1496	
	Silicon G	SG1496	
MC1508	**AD**	**AD559**	**416**
	AMD	SSS1508	
	Datel	DAC-IC8BM	
	PMI	SSS1508	
MC1514	National	LM1514	
	Raytheon	RM1514	
	TI	TL514	
MC1536	Harris	HA-2640	
	National	LM1536	
	Silicon G	SG1536	
MC1537	Raytheon	RM1537	
MC1541	RCA	CA1541	
MC1555	Raytheon	RM555	
	RCA	CA555	
	Signetics	SE555	
	Silicon G	NE555	
	TI	NE555	
MC1556	**Harris**	**HA-2600**	**581**
	Raytheon	RM1556	
		RM1556A	
	Signetics	MC1556	
MC1556	Silicon G	SG1556	
MC1558	AMD	1558	
	Fairchild	μA1558	
	Harris	**HA-2650**	**581**
	National	LM1558	
	PMI	PM1558	
		SSS1558	
	Raytheon	RM1558	
		RM4558	
	RCA	CA1558	
	Signetics	MC1558	
	Silicon G	SG1558	
		SG1558	
	Teledyne S	1558	
	TI	MC1558	
MC1568	Exar	XR1568	
	Silicon G	SG1568	
MC1595	Intech	8595	
	Lithic Sys	LS1595	
	Silicon G	SG1595	
MC1596	Fairchild	μA796	
	Lithic Sys	LS1596	
	National	LM1596	
	Signetics	MC1596	
	Silicon G	SG1596	
MC1648	Plessey	SP1648	
MC1650	Plessey	SP1650	
MC1651	Plessey	SP1651	
MC1658	Fairchild	11C58	
	Plessey	SP1658	
MC1660	Plessey	SP1660	
MC1662	Plessey	SP1662	
MC1664	Plessey	SP1664	
MC1666	Plessey	SP1666	
MC1668	Plessey	SP1668	
MC1670	Plessey	SP1670	
MC1672	Plessey	SP1672	
MC1674	Plessey	SP1674	
MC1690	Fairchild	11C06C	
	Plessey	SP1690	
MC1692	Plessey	SP1692	
MC1709	Fairchild	μA709	
	National	LM1709	
		LM709	
	Raytheon	RC709	
		RM709	
	Signetics	μA709	
	Teledyne S	709	
	TI	μA709	
MC1710	Fairchild	μA710	
	National	LM710	
	Raytheon	RC710	
		RM710	
	Signetics	μA710	
	Silicon G	SG1710	
		SG710	
	Teledyne S	710	
	TI	μA710	
MC1711	Fairchild	μA711	
	National	LM711	
	Raytheon	RC711	
		RM711	
	Signetics	μA711	
	Silicon G	SG1711	
		SG711	
	Teledyne S	711	
	TI	μA711	
MC1712	Fairchild	μA702	
	Raytheon	RC702	
		RM702	
	TI	μA702	
MC1723	AMD	723	
	Fairchild	μA723	
	Intersil	723	
	National	LM723	
	Raytheon	RC723	
		RM723	
	RCA	CA723	
	Signetics	μA723	
	Silicon G	SG1723	
		SG723	
MC1723	Teledyne S	723	
	TI	μA723	
MC1733	AMD	733	
	National	LM733	
	Raytheon	RC733	
		RM733	
	Signetics	μA733	
	Silicon G	SG733	
	TI	μA733	
MC1741	AMD	741	
	Fairchild	μA741	
	Intersil	741	
	National	LM741	
	PMI	OP-02	
		PM741	
		SSS741	
	Raytheon	RC741	
		RM741	
	RCA	CA741	
	Signetics	μA741	
	Silicon G	SG1741	
		SG741	
		SG741	
	Teledyne S	741	
	TI	μA741	
MC1741S	Silicon G	SG1741S	
MC1747	AMD	747	
	Fairchild	μA747	
	PMI	PM747	
	Raytheon	RC747	
		RM747	
	RCA	CA747	
	Signetics	μA747	
	Silicon G	SG747	
	Teledyne S	747	
	TI	μA747	
MC1748	AMD	748	
	Fairchild	μA748	
	Intersil	748	
	National	LM748	
	Raytheon	RC748	
		RM748	
	RCA	CA748	
	Signetics	μA748	
	Silicon G	SG1748	
		SG748	
	Teledyne S	748	
	TI	μA748	
MC1776	Fairchild	μA776	
MC1800	National	DM1800	
	SW	SW1800	
	TI	SN151800	
MC1801	National	DM1801	
	TI	SN151801	
MC1802	SW	SW1802	
	TI	SN151802	
MC1803	TI	SN151803	
MC1804	SW	SW1804	
	TI	SN151804	
MC1805	TI	SN151805	
MC1806	SW	SW1806	
	TI	SN151806	
MC1807	TI	SN151807	
MC1808	SW	SW1808	
	TI	SN151808	
MC1809	TI	SN151809	
MC1810	SW	SW1810	
	TI	SN151810	
MC1811	TI	SN151811	
MC1812	SW	SW1812	
	TI	SN151812	
MC1813	SW	SW1813	
MC1814	SW	SW1814	
MC1900	SW	SW1900	
	TI	SN151900	
MC1901	TI	SN151901	
MC1902	SW	SW1902	
	TI	SN151902	
MC1903	SW	SW1903	
	TI	SN151903	
MC1904	SW	SW1904	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Motorola Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
MC1904	TI	SN151904	
MC1905	TI	SN151905	
MC1906	SW	SW1906	
	TI	SN151906	
MC1907	TI	SN151907	
MC1908	SW	SW1908	
	TI	SN151908	
MC1909	TI	SN151909	
MC1910	SW	SW1910	
	TI	SN151910	
MC1911	TI	SN151911	
MC1912	SW	SW1912	
	TI	SN151912	
MC1914	SW	SW1914	
MC2257	Nitron	NC2257	
MC2259	Nitron	NC2259	
MC2260	Nitron	NC2260	
MC2901	AMD	AM2901	
	Raytheon	AM2901	
MC2909	AMD	AM2909	
	Raytheon	AM2909	
MC2915	AMD	AM2915	
MC2916	AMD	AM2916	
MC2917	AMD	AM2917	
MC2918	AMD	AM2918	
	Raytheon	AM2918	
MC3000	Fairchild	74H00	
		9H00	
	ITT	ITT54H00	
	TI	SN74H00	
MC3001	Fairchild	74H08	
		9H08	
	ITT	ITT7408	
	TI	SN7408	
MC3003	ITT	ITT7432	
	TI	SN7432	
MC3004	Fairchild	74H01	
		9H01	
	ITT	ITT74H01	
	TI	SN74H01	
MC3005	Fairchild	74H10	
		9H10	
	ITT	ITT74H10	
	TI	SN74H10	
MC3006	Fairchild	74H11	
		9H11	
	ITT	ITT74H11	
	TI	SN74H11	
MC3008	Fairchild	74H04	
		9H04	
	ITT	ITT74H04	
	TI	SN74H04	
MC3009	Fairchild	74H05	
		9H05	
	ITT	ITT74H05	
	TI	SN74H05	
MC3010	Fairchild	74H20	
		9H20	
	ITT	ITT74H20	
	TI	SN74H20	
MC3011	Fairchild	74H21	
		9H21	
		9H60	
	ITT	ITT74H21	
	TI	SN74H21	
MC3012	Fairchild	74H22	
		9H22	
	TI	SN74H22	
MC3015	TI	SN74H30	
MC3016	Fairchild	74H30	
		9H30	
	ITT	ITT74H30	
MC3018	Fairchild	74H62	
		9H62	
	TI	SN74H62	
MC3019	Fairchild	74H61	
		9H61	
MC3019	TI	SN74H61	
MC3020	Fairchild	74H50	
		9H50	
	ITT	ITT74H50	
	TI	SN74H50	
MC3021	TI	SN74S86	
MC3023	Fairchild	74H51	
		9H51	
	ITT	ITT74H51	
	TI	SN74H51	
MC3024	Fairchild	74H40	
		9H40	
	ITT	ITT74H40	
	TI	SN74H40	
MC3025	ITT	ITT74H40	
	TI	SN74H40	
MC3030	Fairchild	74H60	
		9H60	
	ITT	ITT74H60	
	TI	SN74H60	
MC3031	Fairchild	74H52	
		9H52	
	TI	SN74H52	
MC3032	Fairchild	74H53	
		9H53	
	ITT	ITT74H53	
	TI	SN74H53	
MC3033	Fairchild	74H54	
		9H54	
	ITT	ITT74H54	
	TI	SN74H54	
MC3034	Fairchild	74H55	
		9H55	
	TI	SN74H55	
MC3054	Fairchild	74H71	
		9H71	
	TI	SN74H71	
MC3055	Fairchild	74H72	
		9H72	
	TI	SN74H72	
MC3060	ITT	ITT74H74	
	TI	SN74H74	
MC3061	Fairchild	9S114	
	TI	SN74S114	
MC3062	Fairchild	9S113	
	TI	SN74S113	
MC3063	Fairchild	74H73	
		9H73	
	ITT	ITT74H73	
	TI	SN74H73	
MC3100	TI	SN54H00	
MC3104	TI	SN54H01	
MC3105	TI	SN54H10	
MC3106	TI	SN54H11	
MC3108	TI	SN54H04	
MC3109	TI	SN54H05	
MC3110	TI	SN54H20	
MC3111	TI	SN54H21	
MC3112	TI	SN54H22	
MC3116	TI	SN54H30	
MC3118	TI	SN54H62	
MC3119	TI	SN54H61	
MC3120	TI	SN54H50	
MC3121	TI	SN54H86	
MC3123	TI	SN54H51	
MC3124	TI	SN54H40	
MC3125	TI	SN54H40	
MC3130	TI	SN54H60	
MC3131	TI	SN54H52	
MC3132	TI	SN54H53	
MC3133	TI	SN54H54	
MC3134	TI	SN54H55	
MC3154	TI	SN54H71	
MC3155	TI	SN54H72	
MC3160	TI	SN54H74	
MC3162	TI	SN54S113	
MC3163	TI	SN54H73	
MC3301	Fairchild	μA3301	
	Raytheon	LM2900	
		RC3301	
MC3302	Fairchild	μA3302	
MC3302	Raytheon	RC3302	
	RCA	CA339	
	Silicon G	SG3302	
	Teledyne S	3302	
MC3401	Fairchild	μA3401	
	Raytheon	LM3900	
		RC3401	
	RCA	CA3401	
MC3403	Exar	XR3403	
	Fairchild	μA3403C	
	Raytheon	**RC3403**	**586**
		RC4137	
MC3416	Raytheon	RC4444	
MC3437	National	DS8837	
MC3438	National	DS8838	
MC3441	**National**	**DS3651**	**489**
MC3443	**National**	**DS3653**	**489**
MC3450	National	DS3650	
MC3452	National	DS3652	
MC3456	Signetics	NE556	
MC3460	**National**	**DS3674**	**488**
MC3503	Exar	XR3503	
	Fairchild	μA3503	
	Raytheon	**RM3503**	**586**
		RM4137	
MC4005	Fairchild	93407	
	TI	SN7481	
MC4015	Raytheon	RL4015	
MC4024	Fairchild	11C24C	
MC4044	Fairchild	11C44C	
MC4064	MMI	6560	
	Signetics	N82S16	
MC4304	TI	SN5481A	
MC4305	TI	SN5481A	
MC4558	Raytheon	RC4558	
MC4741	**Harris**	**HA-4741**	**580**
	National	LM148	
MC5003	TI	SN74186	
MC5005	MMI	6300	
	TI	**SN74S387**	**861**
MC5303	TI	SN54186	
MC5400	Raytheon	5400	
MC5401	Raytheon	5401	
MC5403	Raytheon	5403	
MC5404	Raytheon	5404	
MC5405	Raytheon	5405	
MC5408	Raytheon	5408	
MC5409	Raytheon	5409	
MC5410	Raytheon	5410	
MC5411	Raytheon	5411	
MC5412	Raytheon	5412	
MC54123	Raytheon	54123	
MC54136	Raytheon	54136	
MC54145	Raytheon	54145	
MC5415	Raytheon	5415	
MC54150	Raytheon	54150	
MC54151	Raytheon	54151	
MC54152	Raytheon	54152	
MC54153	Raytheon	54153	
MC54154	Raytheon	54154	
MC54155	Raytheon	54155	
MC54156	Raytheon	54156	
MC54157	Raytheon	54157	
MC54158	Raytheon	54158	
MC54159	Raytheon	54159	
MC54160	Raytheon	54160	
MC54161	Raytheon	54161	
MC54162	Raytheon	54162	
MC54163	Raytheon	54163	
MC54164	Raytheon	54164	
MC54165	Raytheon	54165	
MC54166	Raytheon	54166	
MC54170	Raytheon	54170	
MC54174	Raytheon	54174	
MC54175	Raytheon	54175	
MC54181	Raytheon	54181	
MC54182	Raytheon	54182	
MC54190	Raytheon	54190	
MC54191	Raytheon	54191	
MC54193	Raytheon	54193	
MC54194	Raytheon	54194	
MC54195	Raytheon	54195	
MC54198	Raytheon	54198	
MC54199	Raytheon	54199	
MC5420	Raytheon	5420	
MC5421	Raytheon	5421	
MC5422	Raytheon	5422	
MC54283	Raytheon	54283	
MC5442	Raytheon	5442	
MC5443	Raytheon	5443	
MC5444	Raytheon	5444	
MC5445	Raytheon	5445	
MC5474	Raytheon	5474	
MC5481	Raytheon	5481	
MC5483	Raytheon	5483	
MC5486	Raytheon	5486	
MC55107	AMD	SN55107	
	Fairchild	55107	
	National	**DS55107**	**475**
	Raytheon	RM55107	
	TI	SN55107	
MC55108	AMD	SN55108	
	Fairchild	55108	
	National	**DS55108**	**475**
	Raytheon	RM55108	
	TI	SN55108	
♦MC55109	AMD	SN55109	
	Fairchild	55109	
	Raytheon	RM55109	
	TI	SN55109	
♦MC55110	AMD	SN55110	
	Fairchild	55110	
	Raytheon	RM55110	
	TI	SN55110	
MC5522	National	DS5522	
MC5523	National	DS5523	
MC5524	National	DS5524	
MC5525	National	DS5525	
MC5528	Fairchild	5528	
MC5529	Fairchild	5529	
MC55325	Fairchild	55325	
MC5534	Fairchild	5534	
MC5535	Fairchild	5535	
MC574	Raytheon	5474	
MC6002	TI	TMS4062	
MC6800	**AMI**	**S6800**	**889**
		S6800	**903**
	Fairchild	F6800	
MC6820	**AMI**	**S6820**	**889**
		S6820	**919**
	Mostek	MK6820	
MC6850	**AMI**	**S6850**	**400**
		S6850	**889**
		S6850	**935**
MC6860	**AMI**	**S6860**	**889**
		S6860	**940**
MC7241	Raytheon	RC8241	
	Signetics	N8241	
MC7242	Fairchild	9386	
	Raytheon	RC8242	
	Signetics	N8242	
MC7250	Raytheon	RC8250	
	Signetics	N8250	
MC7251	Raytheon	RC8251	
	Signetics	N8251	
MC7261	Raytheon	RC8261	
	Signetics	N8261	
MC74H00	Raytheon	74H00	
MC74H01	Raytheon	74H01	
MC74H04	Raytheon	74H04	
MC74H05	Raytheon	74H05	
MC74H10	Raytheon	74H10	
MC74H11	Raytheon	74H11	
MC74H20	Raytheon	74H20	
MC74H22	Raytheon	74H22	
MC74H40	Raytheon	74H40	
MC74H74	Raytheon	74H74	
MC7400	Hitachi	HD2503	
	Raytheon	7400	
	TI	SN7400	
MC7401	Hitachi	HD2509	
	Raytheon	7401	

♦ Discontinued

Bold face device numbers indicate manuracturers' data is provided in the IC Master on the pages noted.

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Manufacturer Device	Replacement Source	Device	IC Master Page
MC7401	TI	SN7401	
MC7402	Hitachi	HD2511	
	TI	SN7402	
MC7403	Raytheon	7403	
MC7404	Hitachi	HD2522	
	Raytheon	7404	
	TI	SN7404	
MC7405	Hitachi	HD2523	
	Raytheon	7405	
	TI	SN7405	
MC7408	Raytheon	7408	
MC7409	Raytheon	7409	
MC7410	Hitachi	HD2507	
	Raytheon	7410	
	TI	SN7410	
MC74107	Hitachi	HD2530	
	TI	SN74107	
MC7411	Raytheon	7411	
MC7412	Raytheon	7412	
MC74121	Hitachi	HD2543	
	TI	SN74121	
MC74123	Raytheon	74123	
MC74136	Raytheon	74136	
MC74145	Raytheon	74145	
MC7415	Raytheon	7415	
MC74150	Hitachi	HD2548	
	Raytheon	74150	
	TI	SN74150	
MC74151	Hitachi	HD2549	
	Raytheon	74151	
	TI	SN74151A	
MC74152	Raytheon	74152	
MC74153	Raytheon	74153	
MC74154	Raytheon	74154	
MC74155	Raytheon	74155	
MC74156	Raytheon	74156	
MC74157	Raytheon	74157	
MC74158	Raytheon	74158	
MC74159	Raytheon	74159	
MC74160	Raytheon	74160	
MC74161	Raytheon	74161	
MC74162	Raytheon	74162	
MC74163	Raytheon	74163	
MC74164	Raytheon	74164	
MC74165	Raytheon	74165	
MC74166	Raytheon	74166	
MC74170	Raytheon	74170	
MC74174	Raytheon	74174	
MC74181	Raytheon	74181	
MC74182	Raytheon	74182	
MC74190	Raytheon	74190	
MC74191	Raytheon	74191	
MC74192	Raytheon	74192	
MC74193	Raytheon	74193	
MC74194	Raytheon	74194	
MC74195	Raytheon	74195	
MC74198	Raytheon	74198	
MC74199	Raytheon	74199	
MC7420	Hitachi	HD2504	
	Raytheon	7420	
	TI	SN7420	
MC7421	Raytheon	7421	
MC7422	Raytheon	7422	
MC74283	Raytheon	74283	
MC7430	Hitachi	HD2508	
	TI	SN7430	
MC7440	Hitachi	HD2501	
	TI	SN7440	
MC7441	Hitachi	HD2518	
	TI	SN74141	
MC7442	Raytheon	7442	
MC7443	Raytheon	7443	
MC7444	Raytheon	7444	
MC7445	Raytheon	7445	
MC7450	Hitachi	HD2506	
	TI	SN7450	
MC7451	Hitachi	HD2505	
MC7451	TI	SN7451	
MC7453	Hitachi	HD2512	
	TI	SN7453	
MC7454	Hitachi	HD2514	
	TI	SN7454	
MC7460	Hitachi	HD2502	
	TI	SN7460	
MC7470	Signetics	7470	
	TI	SN7470	
MC7472	Hitachi	HD2529	
	Signetics	7472	
	TI	SN7472	
MC7473	Hitachi	HD2515	
	Signetics	7473	
	TI	SN7473	
MC7474	Hitachi	HD2510	
	Raytheon	MC7474	
	TI	SN7474	
MC7475	Hitachi	HD2517	
	Signetics	7475	
	TI	SN7475	
MC7476	Hitachi	HD2516	
	Signetics	7476	
MC7480	Signetics	7480	
	TI	SN7480	
MC7481	Raytheon	7481	
MC7483	Raytheon	7483	
	Signetics	7483	
MC7486	Raytheon	7486	
MC7490	Hitachi	HD2541	
	Signetics	7490	
	TI	SN7490A	
MC7491	Hitachi	HD2524	
	Signetics	7491	
	TI	SN7491A	
MC7492	Signetics	7492	
	TI	SN7492A	
MC7493	Hitachi	HD2520	
	Signetics	7493	
	TI	SN7493A	
MC7495	Hitachi	HD2534	
	Signetics	7495	
	TI	SN7495A	
MC7496	Hitachi	HD2546	
	TI	SN7496	
♦MC75107	AMD	SN75107	
	Fairchild	75107	
	National	**DS75107**	**475**
	Raytheon	RC75107	
	TI	SN75107A	
♦MC75108	AMD	SN75108	
	Fairchild	75108	
	National	**DS75108**	**475**
	Raytheon	RC75108	
	TI	SN75108A	
MC75109	AMD	SN75109	
	Fairchild	75109	
	ITT	ITT75109	
	Raytheon	RC75109	
	TI	SN75109	
MC75110	AMD	SN75110	
	Fairchild	75110	
	ITT	ITT75110	
	Raytheon	RC75110	
	TI	SN75110	
MC7520	ITT	ITT7520	
	National	DS7520	
	Signetics	7520	
	Silicon G	SG7520	
	TI	SN7520	
MC7521	ITT	ITT7521	
	National	DS7521	
	Signetics	7521	
	Silicon G	SG7521	
	TI	SN7521	
MC7522	ITT	ITT7522	
	National	DS7522	
	Signetics	7522	
	Silicon G	SG7522	
	TI	SN7522	
MC7523	ITT	ITT7523	
MC7523	National	DS7523	
	Signetics	7523	
	Silicon G	SG7523	
	TI	SN7523	
MC75235	ITT	ITT75235	
		ITT7524	
MC7524	Fairchild	7524	
	National	DS7524	
	Signetics	7524	
	Silicon G	SG7524	
	TI	SN7524	
MC7525	Fairchild	7525	
	ITT	ITT7525	
	National	DS7525	
	Signetics	7525	
	Silicon G	SG7525	
	TI	SN7525	
MC7528	Fairchild	7528	
	ITT	ITT7528	
	National	DS7528	
	Silicon G	SG7528	
	TI	SN7528	
MC7529	Fairchild	7529	
	ITT	ITT7529	
	Silicon G	SG7529	
	TI	SN7529	
MC75325	Fairchild	75325	
	National	**DS75325**	**495**
	Raytheon	RC75325	
	Silicon G	SG75325	
	TI	SN75325	
MC7534	Fairchild	7534	
	ITT	ITT7534	
	National	DS7534	
	Silicon G	SG7534	
	TI	SN7534	
MC7535	Fairchild	7535	
	National	DS7535	
	Silicon G	SG7535	
	TI	SN7535	
MC7538	National	DS7538	
	Silicon G	SG7538	
	TI	SN7538	
MC7539	National	DS7539	
	Silicon G	SG7539	
	TI	SN7539	
MC75450	Fairchild	75450	
	ITT	ITT75450	
	National	DS75450	
	Raytheon	RC75450	
	Silicon G	SG75450	
	TI	SN75450	
MC75451	Fairchild	75451	
	ITT	ITT75451	
	National	DS75451	
	Raytheon	RC75451	
	Silicon G	SG75451	
	TI	SN75451	
MC75452	Fairchild	75452	
	National	DS75452	
	Raytheon	RC75452	
	Silicon G	SG75452	
	TI	SN75452	
MC75453	Fairchild	75453	
	ITT	ITT75453	
	National	DS75453	
	Raytheon	RC75453	
	Silicon G	SG75453	
	TI	SN75453	
MC75454	Fairchild	75454	
	ITT	ITT75454	
	Silicon G	SG75454	
MC75491	Fairchild	75491	
	National	DS75491	
	TI	SN75491	
MC75492	Fairchild	75492	
	National	DS75492	
	TI	SN75492	
MC78L05	TI	μA78L05	
MC78L08	TI	μA78L08	
MC78L12	TI	μA78L12	
MC78L15	TI	μA78L15	
MC7805	Fairchild	μA7805	
	National	LM340-5	
	Raytheon	RC7805	
	Signetics	μA7805	
	Silicon G	SG7805	
	TI	μA7805	
MC7806	Fairchild	μA7806	
	National	LM340-6	
	Raytheon	RC7806	
	Signetics	μA7806	
	Silicon G	SG7806	
MC7808	Fairchild	μA7808	
	National	LM340-8	
	Raytheon	RC7808	
	Signetics	μA7808	
	Silicon G	SG7808	
	TI	μA7808	
MC7812	Fairchild	μA7812	
	National	LM340-12	
	Raytheon	RC7812	
	Signetics	μA7812	
	Silicon G	SG7812	
	TI	μA7812	
MC7815	Fairchild	μA7815	
	National	LM340-15	
	Raytheon	RC7815	
	Signetics	μA7815	
	Silicon G	SG7815	
	TI	μA7815	
MC7818	Fairchild	μA7818	
	National	LM340-18	
	Raytheon	RC7818	
	Signetics	μA7818	
	Silicon G	SG7818	
MC7824	Fairchild	μA7824	
	National	LM340-24	
	Raytheon	RC7824	
	Signetics	μA7824	
	Silicon G	SG7824	
	TI	μA7824	
MC7905	Fairchild	μA7905	
	Silicon G	SG320	
	TI	μA7905	
MC7906	Fairchild	μA7906	
	TI	μA7906	
MC7908	Fairchild	μA7908	
	TI	μA7908	
MC7912	Fairchild	μA7912	
	Silicon G	SG320	
	TI	μA7912	
MC7915	Fairchild	μA7915	
	Silicon G	SG320	
	TI	μA7915	
MC7918	Fairchild	μA7918	
	TI	μA7918	
MC7924	Fairchild	μA7924	
	TI	μA7924	
MC7952	Silicon G	SG320	
MC8T13	Fairchild	8T13	
MC8T14	Fairchild	8T14	
MC8T23	Fairchild	8T23	
MC8T24	Fairchild	8T24	
MC8T26	Signetics	N8T26	
MC8T28	Signetics	N8T28	
MC8241	Raytheon	RM8241	
	Signetics	S8241	
MC8242	Fairchild	9386	
	Raytheon	RM8242	
	Signetics	S8242	
MC8250	Raytheon	RM8250	
	Signetics	S8250	
MC8251	Raytheon	RM8251	
	Signetics	S8251	
MC8260	Raytheon	RM8260	
MC8261	Raytheon	RM8261	
	Signetics	S8261	
MC830	Hitachi	HD2204	
	National	DM930	
	SW	SW930	
	TI	SN15930	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Motorola Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Replacement Device	IC Master Page
MC8300	AMD	9300	
	Fairchild	9300	
	Raytheon	RC9300	
	TI	SN74195	
MC8301	AMD	9301	
	Fairchild	9301	
	Signetics	N8252	
	TI	SN29301	
MC8304	AMD	9304	
	Fairchild	9304	
	Raytheon	RC9304	
MC8308	AMD	9308	
	Fairchild	9308	
	Raytheon	RC9308	
	TI	SN29308	
MC8309	AMD	9309	
	Fairchild	9309	
	TI	SN29309	
MC831	SW	SW931	
	TI	SN15831	
MC8310	AMD	9310	
	Fairchild	9310	
	Raytheon	RC9310	
	TI	SN74160	
MC8311	AMD	9311	
	Fairchild	9311	
	Raytheon	RC9311	
	TI	SN74154	
MC8312	AMD	9312	
	Fairchild	9312	
	Raytheon	RC9312	
	Signetics	N8230	
	TI	SN29312	
MC8314	AMD	9314	
MC8316	AMD	9316	
	Fairchild	9316	
	Raytheon	RC9316	
	TI	SN74161	
MC8318	AMD	9318	
	TI	SN29318	
MC832	Hitachi	HD2201	
	National	DM932	
	SW	SW932	
	TI	SN15832	
MC8328	AMD	9328	
	Fairchild	9328	
	Signetics	N8277	
MC833	Hitachi	HD2202	
	National	DM933	
	SW	SW933	
	TI	SN15833	
MC834	TI	SN15834	
MC835	SW	SW936	
	TI	SN15838	
MC836	Hitachi	HD2206	
	National	DM936	
	SW	SW936	
	TI	SN15836	
MC837	National	DM937	
	SW	SW937	
	TI	SN15837	
MC840	National	DM935	
	SW	SW935	
	TI	SN15835	
MC841	TI	SN15835	
MC844	Hitachi	HD2209	
	National	DM944	
	SW	SW844	
MC845	Hitachi	HD2205	
	National	DM945	
	SW	SW945	
	TI	SN15845	
MC846	Hitachi	HD2203	
	National	DM946	
	SW	SW946	
	TI	SN15846	
MC848	National	DM948	
MC848	SW	SW948	
	TI	SN15848	
MC849	National	DM949	
	SW	SW949	
	TI	SN15849	
MC850	SW	SW850	
	TI	SN15850	
MC851	SW	SW951	
	TI	SN15851	
MC852	National	DM9099	
	SW	SW706	
	TI	SN158099	
MC853	National	DM9093	
	SW	SW705	
	TI	SN158093	
MC855	National	DM9097	
	SW	SW709	
	TI	SN158097	
MC856	National	DM9094	
	SW	SW708	
	TI	SN158094	
MC857	Hitachi	HD2213	
	National	DM957	
	SW	SW957	
	TI	SN15857	
MC858	Hitachi	HD2214	
	National	DM958	
	SW	SW958	
	TI	SN15858	
MC8601	AMD	9601	
	Fairchild	9601	
	Raytheon	RF8601	
	Signetics	8T22	
	TI	SN29601	
MC8602	AMD	9602	
	Raytheon	RF8602	
MC861	National	DM961	
	SW	SW961	
	TI	SN15861	
MC862	Hitachi	HD2207	
	National	DM962	
	SW	SW962	
	TI	SN15862	
MC863	National	DM963	
	SW	SW963	
	TI	SN15863	
MC930	Raytheon	RM930	
	SW	SW930	
	TI	SN15930	
MC9300	AMD	9300	
	Raytheon	RM9300	
	TI	SN54195	
MC9301	AMD	9301	
	TI	SN39301	
MC9304	AMD	9304	
	Raytheon	RM9304	
MC9308	AMD	9308	
	Raytheon	RM9308	
	TI	SN39308	
MC931	SW	SW931	
	TI	SN15931	
MC9310	AMD	9310	
	Raytheon	RM9310	
	TI	SN54160	
MC9311	AMD	9311	
	Raytheon	RM9311	
	TI	SN54154	
MC9312	AMD	9312	
	Raytheon	RM9312	
	Signetics	S8230	
	TI	SN39312	
MC9314	AMD	9314	
MC9316	AMD	9316	
	Raytheon	RM9316	
	TI	SN54161	
MC9318	AMD	9318	
	TI	SN39318	
MC932	Raytheon	RM932	
	SW	SW932	
	TI	SN15939	
MC9328	AMD	9328	
MC9328	Signetics	N8277	
MC933	SW	SW933	
	TI	SN15933	
MC934	TI	SN15934	
MC935	Raytheon	RM935	
	SW	SW736	
	TI	SN15938	
MC936	Raytheon	RM936	
	SW	SW936	
	TI	SN15936	
MC937	Raytheon	RM937	
	SW	SW937	
	TI	SN15937	
MC940	Raytheon	RM940	
	SW	SW935	
	TI	SN15935	
MC943	Fairchild	SH2001	
MC944	Raytheon	RM944	
	SW	SW944	
	TI	SN15944	
MC945	Raytheon	RM945	
	SW	SW945	
	TI	SN15945	
MC946	Raytheon	RM946	
	SW	SW946	
	TI	SN15946	
MC948	Raytheon	RM948	
	SW	SW948	
	TI	SN15948	
MC949	Raytheon	RM949	
	SW	SW949	
	TI	SN15949	
MC950	Raytheon	RM950	
	SW	SW950	
	TI	SN15950	
MC951	Raytheon	RM951	
	SW	SW951	
	TI	SN15951	
MC952	Raytheon	RM952	
	SW	SW952	
	TI	SN159099	
MC953	SW	SW953	
	TI	SN159093	
MC955	TI	SN159097	
MC956	TI	SN159094	
MC957	Raytheon	RM957	
	SW	SW957	
	TI	SN15957	
MC958	Raytheon	RM958	
	SW	SW958	
	TI	SN15958	
MC9601	AMD	9601	
	Raytheon	RF9601	
	Signetics	S8T22	
	TI	SN29601	
MC9602	AMD	9602	
	Raytheon	RF9602	
MC961	Raytheon	RM961	
	SW	SW961	
	TI	SN15961	
MC962	Raytheon	RM962	
	SW	SW962	
	TI	SN15962	
MC963	Raytheon	RM963	
	SW	SW963	
	TI	SN15963	
♦MFC4000	Motorola	MC3360	
♦MFC4010	Motorola	MC3310	
♦MFC6040	Motorola	MC3340	
♦MFC8030	Motorola	MC3330	
♦MFC8070	Motorola	MC3370	
MLM101	AMD	LM101	
	Fairchild	μA101	
	Intersil	LM101	
	National	LM101	
	RCA	CA101	
	Signetics	LM101	
	Silicon G	SG101	
	Teledyne S	LM101	
	TI	LM101	
MLM104	Fairchild	μA104	
MLM104	National	LM104	
	Raytheon	LM104	
	Silicon G	SG104	
	Teledyne S	LM104	
	TI	LM104	
MLM105	AMD	LM105	
	Fairchild	μA105	
	Intersil	LM105	
	National	LM105	
	Raytheon	LM105	
	Silicon G	SG105	
	Teledyne S	LM105	
	TI	LM105	
MLM107	AMD	LM107	
	Fairchild	μA107	
	Intersil	LM107	
	National	LM107	
	Raytheon	LM107	
	RCA	CA107	
	Signetics	LM107	
	Silicon G	SG107	
	TI	LM107	
MLM108	RCA	CA108	
	Silicon G	SG108	
		SG208	
MLM109	Fairchild	μA109	
	National	LM109	
	Raytheon	LM109	
	Signetics	LM109	
	Silicon G	SG109	
	TI	LM109	
MLM110	AMD	LM110	
	Fairchild	μA110	
	Intersil	LM110	
	National	LM110	
	Silicon G	SG110	
MLM111	AMD	LM111	
	National	LM111	
	Raytheon	LM111	
	RCA	CA111	
	Silicon G	SG111	
	Teledyne S	LM111	
	TI	LM111	
MLM158	National	LM158	
MLM201	AMD	LM201	
	Fairchild	μA201	
	Intersil	LM201	
	National	LM201	
	RCA	CA201	
	Signetics	LM201	
	Silicon G	SG201	
	Teledyne S	LM201	
	TI	LM201	
MLM204	Fairchild	μA204	
	National	LM204	
	Raytheon	LM204	
	Silicon G	SG204	
	Teledyne S	LM204	
	TI	LM204	
MLM205	AMD	LM205	
	Intersil	LM205	
	National	LM205	
	Raytheon	LM205	
	Silicon G	SG205	
	Teledyne S	LM205	
	TI	LM205	
MLM207	AMD	LM207	
	Fairchild	μA207	
	Intersil	LM207	
	National	LM207	
	Raytheon	LM207	
	RCA	CA207	
	Signetics	LM207	
	Silicon G	SG207	
	TI	LM207	
MLM208	RCA	CA208	
	Silicon G	SG208	
MLM209	AMD	LM209	
	Fairchild	μA209	
	National	LM209	
	Raytheon	LM209	

♦ Discontinued

Bold face device numbers indicate manufacturers' data is provided in the IC Master on the pages noted.

Motorola Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
MLM209	Signetics	LM209	
	Silicon G	SG209	
	TI	LM209	
MLM210	AMD	LM210	
	Fairchild	μA210	
	Intersil	LM210	
	National	LM210	
	Silicon G	SG210	
MLM211	AMD	LM211	
	Intersil	LM211	
	National	LM211	
	Raytheon	LM211	
	RCA	CA211	
	Silicon G	SG211	
	Teledyne S	LM211	
	TI	LM211	
MLM258	National	LM258	
MLM301	AMD	LM301	
	Fairchild	μA301	
	Intersil	LM301	
	National	LM301	
	Raytheon	LM301	
	RCA	CA301	
	Signetics	LM301	
	Silicon G	SG301	
	Teledyne S	LM301	
	TI	LM301	
MLM304	Fairchild	μA304	
	National	LM304	
	Raytheon	LM304	
	Silicon G	SG304	
	Teledyne S	LM304	
	TI	LM304	
MLM305	AMD	LM305	
	Fairchild	μA305	
	Intersil	LM305	
	National	LM305	
	Raytheon	LM305	
	Silicon G	SG305	
	Teledyne S	LM305	
	TI	LM305	
MLM307	AMD	LM307	
	Fairchild	μA307	
	Intersil	LM307	
	National	LM307	
	Raytheon	LM307	
	RCA	CA307	
	Signetics	LM307	
	Silicon G	SG307	
	TI	LM307	
MLM308	RCA	CA308	
	Silicon G	SG308	
		SG308	
MLM309	AMD	LM309	
	Fairchild	μA309	
	National	LM309	
	Raytheon	LM309	
	Signetics	LM309	
	Silicon G	SG309	
	TI	LM309	
MLM310	AMD	LM310	
	Fairchild	μA310	
	Intersil	LM310	
	National	LM310	
	Silicon G	SG310	
MLM311	AMD	LM311	
	Fairchild	μA311	
	Intersil	LM311	
	National	LM311	
	Raytheon	LM311	
	RCA	CA311	
	Silicon G	SG311	
	Teledyne S	LM311	
	TI	LM311	
MLM358	National	LM358	
MMH0026	**National**	**DS0026**	**474**
MQ3724	RCA	CA3724	
MQ3725	RCA	CA3725	
NE592	AMD	NE592	
SE592	AMD	SE592	

National Semiconductor

Manufacturer Device	Replacement Source	Device	IC Master Page
AH0126	Siliconix	DG126	
AH0129	Siliconix	DG129	
AH0133	Siliconix	DG133	
AH0134	Siliconix	DG134	
AH0139	Siliconix	DG139	
AH0140	Siliconix	DG140	
AH0141	Siliconix	DG141	
AH0142	Siliconix	DG142	
AH0143	Siliconix	DG143	
AH0144	Siliconix	DG144	
AH0145	Siliconix	DG145	
AH0146	Siliconix	DG146	
AH0151	Siliconix	DG151	
AH0152	Siliconix	DG152	
AH0153	Siliconix	DG153	
AH0154	Siliconix	DG154	
AH0161	Siliconix	DG161	
AH0162	Siliconix	DG162	
AH0163	Siliconix	DG163	
AH0164	Siliconix	DG164	
CD4001	Harris	HD4001	
	Mitel	SIL4001	
		SIL4901	
	RCA	CD4001	
	SSS	SCL4001	
CD4002	Harris	HD4002	
	RCA	CD4002	
	SSS	SCL4002	
CD4007	Harris	HD4007	
	Mitel	SIL4007	
	RCA	CD4007	
	SSS	SCL4007	
CD4009	Mitel	SIL4009	
	RCA	CD4009	
	SSS	SCL4009	
CD4010	Mitel	SIL4010	
	RCA	CD4010	
	SSS	SCL4010	
CD4011	Mitel	SIL4011	
		SIL4911	
	RCA	CD4011	
	SSS	SCL4011	
CD4012	Harris	HD4012	
	Mitel	SIL4012	
		SIL4912	
	RCA	CD4012	
	SSS	SCL4012	
CD4013	Harris	HD4013	
	Mitel	SIL4013	
	RCA	CD4013	
	SSS	SCL4013	
CD4014	Harris	HD4014	
	Mitel	SIL4014	
	RCA	CD4014	
	SSS	SCL4014	
CD4015	Harris	HD4015	
	Mitel	SIL4015	
	RCA	CD4015	
	SSS	SCL4015	
CD4016	Mitel	SIL4016	
	RCA	CD4016	
	SSS	SCL4016	
CD4017	Harris	HD4017	
	Mitel	SIL4017	
	RCA	CD4017	
	SSS	SCL4017	
CD4018	Harris	HD4018	
	Mitel	SIL4018	
	RCA	CD4018	
	SSS	SCL4018	
CD4019	Harris	HD4019	
	Mitel	SIL4019	
	RCA	CD4019	
	SSS	SCL4019	
CD4020	Harris	HD4020	
	Mitel	SIL4020	
	RCA	CD4020	
	SSS	SCL4020	
CD4021	Harris	HD4021	
	Mitel	SIL4021	
	RCA	CD4021	
	SSS	SCL4021	
CD4022	Harris	HD4022	
	Mitel	SIL4022	
	RCA	CD4022	
	SSS	SCL4022	
CD4023	Harris	HD4023	
	Mitel	SIL4023	
		SIL4923	
	RCA	CD4023	
	SSS	SCL4023	
CD4024	Mitel	SIL4024	
CD4025	Harris	HD4025	
	Mitel	SIL4025	
		SIL4925	
	RCA	CD4025	
	SSS	SCL4025	
CD4027	Harris	HD4027	
	Mitel	SIL4027	
	RCA	CD4027	
CD4028	Mitel	SIL4028	
CD4029	Mitel	SIL4029	
CD4030	Harris	HD4030	
	Mitel	SIL4030	
	RCA	CD4030	
	SSS	SCL4030	
CD4035	Harris	HD4035	
	Mitel	SIL4035	
	RCA	CD4035	
	SSS	SCL4035	
CD4040	Mitel	SIL4040	
CD4042	Mitel	SIL4042	
CD4043	Mitel	SIL4043	
CD4044	Mitel	SIL4044	
CD4049	Harris	HD4049	
	Mitel	SIL4049	
	RCA	CD4049	
	SSS	SCL4049	
CD4050	Harris	HD4050	
	Mitel	SIL4050	
	RCA	CD4050	
	SSS	SCL4050	
CD4051	Harris	HD4051	
	Mitel	SIL4051	
CD4052	Harris	HD4052	
	Mitel	SIL4052	
CD4053	Mitel	SIL4053	
CD4066	Harris	HD4066	
	Mitel	SIL4066	
	RCA	CD4066	
	SSS	SCL4066	
CD4069	Harris	HD4069	
	Mitel	SIL4069	
CD4070	Harris	HD4070	
	Mitel	SIL4070	
CD4076	Harris	HD4076	
	Mitel	SIL4076	
CD4081	Harris	HD4081	
CD4503	Harris	HD14503	
CD4510	Mitel	SIL4510	
CD4511	Harris	HD14511	
	Mitel	SIL4511	
	SSS	SCL4511	
CD4514	Harris	HD14514	
CD4515	Harris	HD14515	
CD4518	Mitel	SIL4518	
CD4520	Mitel	SIL4520	
CD4527	Harris	HD14527	
CD4528	Harris	HD14528	
♦DH3724	RCA	CA3724	
DH3725	RCA	CA3725	
DM10101	Motorola	MC10101	
DM10102	Motorola	MC10102	
DM10105	Motorola	MC10105	
DM10106	Motorola	MC10106	
♦DM10107	Motorola	MC10107	
DM10109	Motorola	MC10109	
♦DM10110	Motorola	MC10110	
DM10111	Motorola	MC10111	
DM10115	Motorola	MC10115	
♦DM10116	Motorola	MC10116	
DM10117	Motorola	MC10117	
DM10118	Motorola	MC10118	
DM10119	Motorola	MC10119	
DM10121	Motorola	MC10121	
DM10124	Motorola	MC10124	
♦DM10130	Motorola	MC10130	
♦DM1800	Motorola	MC1800	
	SW	SW1800	
♦DM1801	Motorola	MC1801	
DM54H00	Fairchild	54H00	
		9H00	
	Raytheon	54H00	
DM54H01	Raytheon	54H01	
DM54H04	Raytheon	54H04	
DM54H05	Raytheon	54H05	
DM54H10	Raytheon	54H10	
DM54H11	Raytheon	54H11	
DM54H20	Raytheon	54H20	
DM54H22	Raytheon	54H22	
DM54H40	Raytheon	54H40	
DM54H74	Raytheon	54H74	
DM54L187	Intersil	IM5603	
DM54L89	MMI	L5560	
	TI	**SN54S287**	**861**
DM54S387	Intel	M3601	
	MMI	5300	
	TI	**SN54S387**	**861**
DM5400	Fairchild	5400	
		9N00	
	Raytheon	5400	
	Signetics	5400	
DM5401	Raytheon	5401	
	Signetics	5401	
	TI	SN5401	
DM5402	Signetics	5402	
	TI	SN5402	
DM5403	Raytheon	5403	
	Signetics	5403	
	TI	SN5403	
DM5404	Raytheon	5404	
	Signetics	5404	
	TI	SN5404	
DM5405	Raytheon	5405	
	Signetics	5405	
	TI	SN5405	
DM5406	Signetics	5406	
	TI	SN5406	
DM5408	Raytheon	5408	
	Signetics	5408	
	TI	SN5408	
DM5409	Raytheon	5409	
	Signetics	5409	
	TI	SN5409	
DM5410	Raytheon	5410	
	Signetics	5410	
	TI	SN5410	
DM54107	Signetics	54107	
	TI	SN54107	
DM5411	Raytheon	5411	
	Signetics	5411	
♦DM5412	Raytheon	5412	
DM54123	Raytheon	54123	
DM5413	Signetics	5413	
	TI	SN5413	
♦DM54136	Raytheon	54136	
DM54145	Raytheon	54145	
♦DM5415	Raytheon	5415	
DM54150	Raytheon	54150	
DM54151	Raytheon	54151	
♦DM54152	Raytheon	54152	
DM54153	AMD	SN54153	
	Raytheon	54153	
	TI	SN54153	
DM54154	AMD	SN54154	
	Raytheon	54154	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

National Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
DM54154	TI	SN54154	
DM54155	Raytheon	54155	
DM54156	Raytheon	54156	
DM54157	AMD	SN54157	
	Raytheon	54157	
	TI	SN54157	
♦DM54158	Raytheon	54158	
♦DM54159	Raytheon	54159	
DM5416	Signetics	5416	
	TI	SN5416	
DM54160	Raytheon	54160	
DM54161	Raytheon	54161	
DM54162	Raytheon	54162	
DM54163	Raytheon	54163	
DM54164	AMD	SN54164	
	Raytheon	54164	
	TI	SN54164	
DM54165	Raytheon	54165	
DM54166	Raytheon	54166	
DM5417	Signetics	5417	
	TI	SN5417	
♦DM54170	Raytheon	54170	
DM54174	Raytheon	54174	
DM54175	Raytheon	54175	
DM54181	AMD	SN54181	
	Raytheon	54181	
	TI	SN54181	
DM54182	Raytheon	54182	
♦DM54187	Intersil	IM5603	
	MMI	5200	
	National	**DM54S187**	**702**
	TI	SN54187	
DM54190	Raytheon	54190	
DM54191	Raytheon	54191	
DM54192	AMD	SN54192	
	Raytheon	54192	
	TI	SN54192	
DM54193	AMD	SN54193	
	Raytheon	54193	
	TI	SN54193	
DM54194	Raytheon	54194	
DM54195	AMD	SN54195	
	Raytheon	54195	
	TI	SN54195	
DM54198	Raytheon	54198	
DM54199	Raytheon	54199	
DM5420	Raytheon	5420	
	Signetics	5420	
	TI	SN5420	
♦DM54200	Intersil	IM5523	
	MMI	5531	
	Raytheon	RM5340	
	TI	SN54S201	
♦DM5421	Raytheon	5421	
♦DM5422	Raytheon	5422	
♦DM54283	Raytheon	54283	
DM5430	Signetics	5430	
	TI	SN5430	
DM5432	Signetics	5432	
	TI	SN5432	
DM5437	Signetics	5437	
	TI	SN5437	
DM5438	Signetics	5438	
	TI	SN5438	
DM5440	Signetics	5440	
	TI	SN5440	
DM5442	Raytheon	5442	
♦DM5443	Raytheon	5443	
♦DM5444	Raytheon	5444	
DM5445	Raytheon	5445	
	Signetics	5445	
DM5450	Signetics	5450	
	TI	SN5450	
DM5451	Signetics	5451	
	TI	SN5451	
DM5453	Signetics	5453	
	TI	SN5453	
DM5454	Signetics	5454	
	TI	SN5454	
DM5460	Signetics	5460	
	TI	SN5460	
DM5472	Signetics	5472	
	TI	SN5472	
DM5473	Signetics	5473	
	TI	SN5473	
DM5474	Raytheon	5474	
	Signetics	5474	
	TI	SN5474	
DM5475	Signetics	5475	
	TI	SN5475	
DM5476	Signetics	5476	
	TI	SN5476	
DM5481	Raytheon	5481	
DM5483	Raytheon	5483	
DM5486	Raytheon	5486	
	Signetics	5486	
	TI	SN5486	
DM5488	Intersil	IM5600	
	MMI	5230	
	TI	SN5488A	
DM5489	AMD	SN5489	
		31013	
	Intersil	IM5501	
	MMI	5560	
	Raytheon	5489	
DM5490	Signetics	5490	
	TI	SN5490A	
DM5491	Signetics	5491	
	TI	SN5491A	
DM5492	Signetics	5492	
	TI	SN5492A	
DM5493	Signetics	5493	
	TI	SN5493A	
DM7093	TI	SN54125	
DM7094	TI	SN54126	
DM7095	TI	SN54365	
DM7096	TI	SN54366	
DM7097	TI	SN54367	
DM7098	TI	SN54368	
DM71L22	TI	SN54L157	
DM71S60	Fairchild	93S43	
DM7121	TI	SN54251	
DM74H00	Fairchild	74H00	
		9HQ0	
	Raytheon	74H00	
	Signetics	74H00	
	TI	SN74H00	
DM74H01	Raytheon	74H01	
	Signetics	74H01	
DM74H04	Raytheon	74H04	
	Signetics	74H04	
	TI	SN74H04	
DM74H05	Raytheon	74H05	
	Signetics	74H05	
	TI	SN74H05	
DM74H08	Signetics	74H08	
DM74H10	Raytheon	74H10	
	Signetics	74H10	
	TI	SN74H10	
DM74H11	Raytheon	74H11	
	Signetics	74H11	
	TI	SN74H11	
DM74H20	Raytheon	74H20	
	Signetics	74H20	
	TI	SN74H20	
DM74H21	Signetics	74H21	
	TI	SN74H21	
DM74H22	Raytheon	74H22	
	Signetics	74H22	
	TI	SN74H22	
DM74H30	Signetics	74H30	
	TI	SN74H30	
DM74H40	Raytheon	74H40	
	Signetics	74H40	
	TI	SN74H40	
DM74H50	Signetics	74H50	
	TI	SN74H50	
DM74H51	Signetics	74H51	
DM74H51	TI	SN74H51	
DM74H53	Signetics	74H53	
	TI	SN74H53	
DM74H54	Signetics	74H54	
	TI	SN74H54	
DM74H55	Signetics	74H55	
	TI	SN74H55	
DM74H60	Signetics	74H60	
	TI	SN74H60	
DM74H62	Signetics	74H62	
	TI	SN74H62	
DM74H74	Raytheon	74H74	
DM74L187	Intersil	IM5603	
DM74L63	TI	SN54L193	
DM74L89	MMI	L6560	
DM74S200	Signetics	74S200	
DM74S387	**Intel**	**3601-1**	**695**
	MMI	6300	
	Signetics	N82S126	
	TI	**SN74S387**	**861**
DM74S572	**Intel**	**3605**	**699**
DM74S573	**Intel**	**3625**	**699**
DM7400	Fairchild	7400	
		9N00	
	Hitachi	HD2503	
	Raytheon	7400	
	Signetics	7400	
	TI	SN7400	
DM7401	Hitachi	HD2509	
	Raytheon	7401	
	Signetics	7401	
	TI	SN7401	
DM7402	Hitachi	HD2511	
	Signetics	7402	
	TI	SN7402	
DM7403	Hitachi	HD2528	
	Raytheon	7403	
	Signetics	7403	
	TI	SN7403	
DM7404	Hitachi	HD2522	
	Raytheon	7404	
	Signetics	7404	
	TI	SN7404	
DM7405	Hitachi	HD2523	
	Raytheon	7405	
	Signetics	7405	
	TI	SN7405	
DM7407	Signetics	7407	
	TI	SN7407	
DM7408	Hitachi	HD2550	
	Raytheon	7408	
	Signetics	7408	
	TI	SN7408	
DM7409	Hitachi	HD2551	
	Raytheon	7409	
	Signetics	7409	
	TI	SN7409	
DM7410	Hitachi	HD2507	
	Raytheon	7410	
	Signetics	7410	
	TI	SN7410	
DM74107	Hitachi	HD2530	
	Signetics	74107	
	TI	SN74107	
DM7411	Raytheon	7411	
	Signetics	7411	
♦DM7412	Raytheon	7412	
DM74121	Signetics	74121	
	TI	SN74121	
DM74123	AMD	SN74123	
	Fairchild	74123	
	Signetics	74123	
	TI	SN74123	
DM74125	Signetics	74125	
	TI	SN74425	
DM74126	Signetics	74126	
	TI	SN74426	
DM7413	Signetics	7413	
	TI	SN7413	
♦DM74136	Raytheon	74136	
DM74141	Signetics	74141	
DM74141	TI	SN74141	
DM74145	Raytheon	74145	
	Signetics	74145	
	TI	SN74145	
♦DM7415	Raytheon	7415	
DM74150	Raytheon	74150	
	Signetics	74150	
	TI	SN74150	
DM74151	Raytheon	74151	
	Signetics	74151	
	TI	SN74151A	
♦DM74152	Raytheon	74152	
DM74153	AMD	SN74153	
	Hitachi	HD2564	
	Raytheon	74153	
	Signetics	74153	
	TI	SN74153	
DM74154	AMD	SN74154	
	Hitachi	HD2580	
	Raytheon	74154	
	Signetics	74154	
	TI	SN74154	
DM74155	Raytheon	74155	
	Signetics	74155	
	TI	SN74155	
DM74156	Raytheon	74156	
	Signetics	74156	
	TI	SN74156	
DM74157	AMD	SN74157	
	Raytheon	74157	
	Signetics	74157	
	TI	SN74157	
♦DM74158	Raytheon	74158	
♦DM74159	Raytheon	74159	
DM7416	Signetics	7416	
	TI	SN7416	
DM74160	AMD	SN74160	
	Raytheon	74160	
	Signetics	74160	
	TI	SN74160	
DM74161	Raytheon	74161	
DM74162	Raytheon	74162	
	Signetics	74162	
	TI	SN74162	
DM74163	AMD	SN74163	
	Raytheon	74163	
	Signetics	74163	
	TI	SN74163	
DM74164	AMD	SN74164	
	Raytheon	74164	
	Signetics	74164	
	TI	SN74164	
DM74165	Raytheon	74165	
	Signetics	74165	
	TI	SN74165	
DM74166	Raytheon	74166	
	Signetics	74166	
	TI	SN74166	
DM7417	Signetics	7417	
	TI	SN7417	
DM74170	Fairchild	74170	
	Hitachi	HD2540	
	Raytheon	74170	
	Signetics	74170	
	TI	SN74170	
DM74172	Signetics	74S172	
		74172	
	TI	SN74172	
DM74174	AMD	SN74174	
	Raytheon	74174	
	Signetics	74174	
	TI	SN74174	
DM74175	AMD	SN74175	
	Raytheon	74175	
	Signetics	74175	
	TI	SN74175	
DM74180	Signetics	74180	
	TI	SN74180	
DM74181	AMD	SN74181	
	Raytheon	74181	
	Signetics	74181	

♦ Discontinued

Bold face device numbers indicate manufacturers' data is provided in the IC Master on the pages noted.

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Manufacturer Device	Replacement Source	Device	IC Master Page
DM74181	TI	SN74181	
♦DM74187	Intersil	IM5603	
	MMI	6200	
	National	**DM74S187**	**702**
	Signetics	N82S226	
	TI	SN74187	
DM74190	Raytheon	74190	
	Signetics	74190	
	TI	SN74190	
DM74191	Raytheon	74191	
	Signetics	74191	
	TI	SN74191	
DM74192	AMD	SN74192	
	Raytheon	74192	
	Signetics	74192	
	TI	SN74192	
DM74193	AMD	SN74193	
	Raytheon	74193	
	Signetics	74193	
	TI	SN74193	
DM74194	Raytheon	74194	
DM74195	AMD	SN74195	
	Raytheon	74195	
	Signetics	74195	
	TI	SN74195	
DM74198	Raytheon	74198	
	Signetics	74198	
	TI	SN74198	
DM74199	Raytheon	74199	
	Signetics	74199	
	TI	SN74199	
DM7420	Hitachi	HD2504	
	Raytheon	7420	
	Signetics	7420	
	TI	SN7420	
♦DM74200	Fairchild	93421	
	Intersil	IM5523	
	MMI	6531	
	Raytheon	RC5340	
	TI	SN74S201	
♦DM7421	Raytheon	7421	
♦DM7422	Raytheon	7422	
DM7426	Signetics	7426	
	TI	SN7426	
♦DM74283	Raytheon	74283	
DM74287	**Intel**	**3621-1**	**695**
DM7430	Hitachi	HD2508	
	Signetics	7430	
	TI	SN7430	
DM7440	Hitachi	HD2501	
	Signetics	7440	
	TI	SN7440	
DM7441	Hitachi	HD2518	
	Signetics	7441	
	TI	SN74141	
DM7442	Hitachi	HD2536	
	Raytheon	7442	
	Signetics	7442	
	TI	SN7442A	
♦DM7443	Raytheon	7443	
♦DM7444	Raytheon	7444	
DM7445	Raytheon	7445	
	Signetics	7445	
	TI	SN7445	
DM7446	Hitachi	HD2553	
	TI	SN7446A	
DM7447	Hitachi	HD2532	
	Signetics	7447	
	TI	SN7447A	
DM7448	Signetics	7448	
	TI	SN7448	
DM7450	Hitachi	HD2506	
	Signetics	7450	
	TI	SN7450	
DM7451	Hitachi	HD2505	
	Signetics	7451	
	TI	SN7451	
DM7453	Hitachi	HD2512	
	Signetics	7453	
	TI	SN7453	
DM7454	Hitachi	HD2514	
	Signetics	7454	
	TI	SN7454	
DM7460	Signetics	7460	
	TI	SN7460	
DM7472	Hitachi	HD2529	
	Signetics	7472	
	TI	SN7472	
DM7473	Hitachi	HD2515	
	Signetics	7473	
	TI	SN7473	
DM7474	Hitachi	HD2510	
	Raytheon	7474	
	Signetics	7474	
	TI	SN7474	
DM7475	Hitachi	HD2517	
	Signetics	7475	
	TI	SN7475	
DM7476	Hitachi	HD2516	
	Signetics	7476	
♦DM7481	Raytheon	7481	
DM7483	Hitachi	HD2535	
	Raytheon	7483	
	Signetics	7483	
	TI	SN7483A	
DM7486	Hitachi	HD2526	
	Raytheon	7486	
	Signetics	7486	
	TI	SN7486	
DM7488	Intersil	IM5600	
	MMI	6230	
	TI	SN7488A	
DM7489	AMD	C3101	
		SN7489	
	Intersil	IM5501	
	MMI	6560	
	Raytheon	7489	
	TI	SN7489	
DM7490	Hitachi	HD2519	
	Signetics	7490	
	TI	SN7490A	
DM7491	Signetics	7491	
	TI	SN7491A	
DM7492	Hitachi	HD2521	
	Signetics	7492	
	TI	SN7492A	
DM7493	Hitachi	HD2520	
	Signetics	7493	
	TI	SN7493A	
DM7495	Hitachi	HD2534	
	Signetics	7495	
	TI	SN7495A	
DM7496	Hitachi	HD2546	
	Signetics	7496	
DM75L60	TI	SN54L192	
DM75491	National	DS75491	
DM75492	National	DS75492	
DM7551	TI	SN54173	
DM7560	TI	SN54192	
DM7563	TI	SN54193	
DM7570	TI	SN54164	
DM7573	Harris	HPROM1024A	
	Intel	M3601	
	Intersil	IM5603	
	MMI	5300	
	National	**DM54S387**	**708**
	TI	**SN54S387**	**861**
♦DM7574	AMD	AM27S09	
	Harris	**HM7602**	**682**
		HPROM1024	
	Intersil	IM5623	
	MMI	5301	
	National	**DM54S287**	**708**
	TI	**SN54S287**	**861**
DM7577	**Harris**	**HM7602**	**682**
	TI	**SN54S188**	**860**
DM7578	**Harris**	**HM7603**	**682**
	TI	SN54S288	
♦DM7582	Intersil	IM5533	
	TI	SN54S301	
DM7590	TI	SN54165	
♦DM7597	Intersil	IM5623	
	MMI	5201	
	National	**DM75S97**	**702**
	TI	**SN54S287**	**861**
		SN54S370	
DM7598	Intersil	IM5610	
	MMI	5231	
	National	DM75598	
DM7599	AMD	AM27S03	
		DM7599	
	MMI	5561	
	TI	SN54S189	
DM76L97	Intersil	IM5623	
♦DM76L99	Intersil	IM5501	
	MMI	L5561	
	National	**DM54S189**	**746**
♦DM7640	National	DS7640	
♦DM7795	**National**	**DM77S95**	**735**
DM7796	MMI	5241	
	National	**DM77S96**	**735**
♦DM78XX	National	DS78XX	
DM7800	TI	SN55180	
♦DM7893	National	DS55493	
♦DM7894	National	DS55494	
DM8093	TI	SN74125	
DM8094	TI	SN74126	
DM8095	TI	SN74365	
DM8096	TI	SN74366	
DM8097	TI	SN74367	
DM8098	TI	SN74368	
♦DM81L22	TI	SN74L157	
♦DM81S60	Fairchild	93S47	
DM8200	Signetics	N8269	
♦DM8213	Fairchild	9311	
	ITT	ITT74154	
	Motorola	MC8311	
	Raytheon	RC9311	
	Signetics	74154	
	TI	SN74154	
DM8220	Hitachi	HD2525	
DM8280	Fairchild	93176	
	Raytheon	RC8280	
	Signetics	N8280	
	TI	SN74176	
DM8281	Fairchild	93177	
	Raytheon	RC8281	
	Signetics	N8281	
	TI	SN74177	
♦DM8283	Fairchild	9383	
	Motorola	MC7483	
	Signetics	7483	
	TI	SN7483A	
DM8288	Signetics	N8288	
DM8290	Fairchild	93196	
	Raytheon	RC8290	
DM8291	Fairchild	93197	
	Raytheon	RC8291	
	TI	SN74197	
♦DM8296	TI	SN74196	
DM8300	AMD	9300	
	Fairchild	9300	
	Raytheon	RC9300	
	TI	SN29300	
DM8301	AMD	9301	
	TI	SN29301	
DM8309	AMD	9309	
	Fairchild	9309	
	TI	SN29309	
DM8310	AMD	9310	
	Fairchild	9310	
	Raytheon	RC9310	
	TI	SN29310	
DM8311	AMD	9311	
	Fairchild	9311	
	Raytheon	RC9311	
	TI	SN29311	
DM8312	AMD	9312	
	Fairchild	9312	
DM8312	Raytheon	RC9312	
	TI	SN29312	
DM8316	AMD	9316	
	Fairchild	9316	
	Raytheon	RC9316	
	TI	SN29316	
DM8322	AMD	9322	
	Fairchild	9322	
	Raytheon	RC9322	
		74154	
		74157	
	TI	SN29322	
DM85L60	TI	SN74L192	
DM85L63	TI	SN74L193	
♦DM85S99	AMD	SN74S189	
	TI	SN74S189	
♦DM8500	Signetics	7476	
	TI	SN7476	
♦DM8501	Signetics	7473	
	TI	SN7473	
♦DM8510	Signetics	7474	
	TI	SN7474	
♦DM8530	Fairchild	9390	
	Motorola	MC7490	
	Signetics	7490	
	TI	SN7490A	
♦DM8532	Fairchild	9392	
	Motorola	MC7492	
	Signetics	7492	
	TI	SN7492A	
♦DM8533	Fairchild	9393	
	Motorola	MC7493	
	Signetics	7493	
	TI	SN7493A	
♦DM8550	Fairchild	9375	
	Motorola	MC7475	
	Signetics	7475	
	TI	SN7475	
DM8551	TI	SN74173	
DM8560	Fairchild	9360	
	Hitachi	HD2541	
	ITT	ITT74192	
	Motorola	MC74192	
	Raytheon	74192	
	Signetics	74192	
	TI	SN74192	
DM8563	Fairchild	9366	
	Hitachi	HD2542	
	ITT	ITT74193	
	Motorola	MC74193	
	Raytheon	74193	
	Signetics	74193	
	TI	SN74193	
DM8570	Fairchild	93164	
	Motorola	MC74164	
	Raytheon	74164	
	TI	SN74164	
♦DM8573	Fairchild	93416	
	Harris	HPROM1024A	
	Intel	**3601**	**695**
	Intersil	IM5603	
	MMI	6300	
	National	**DM74S387**	**708**
	Signetics	N82S126	
	TI	**SN74S387**	**861**
♦DM8574	Fairchild	93426	
	Harris	HPROM1024	
	Intel	**3621**	**695**
	Intersil	IM5603	
		IM5623	
	MMI	6301	
	National	**DM74S287**	**708**
	TI	**SN74S287**	**861**
DM8577	AMD	AM27S08	
	Harris	**HM7602**	**682**
	TI	**SN74S188**	**860**
DM8578	**Harris**	**HM7603**	**682**
	MMI	6331	
	Signetics	N82S123	
	TI	SN74S288	
♦DM8580	Fairchild	9395	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

National Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
DM8580	Motorola	MC7495	
	Signetics	7495	
	TI	SN7495A	
♦DM8582	Fairchild	93411	
	Intersil	IM5533	
	MMI	6530	
	TI	SN74S301	
♦DM8588	Intersil	IM5600	
	TI	**SN74S188**	**860**
DM8590	Fairchild	93165	
	Raytheon	74165	
	TI	SN74165	
♦DM8597	Intersil	IM5623	
	MMI	6201	
	National	**DM85S97**	**702**
	TI	**SN74S287**	**861**
		SN74S370	
DM8598	Intersil	IM5610	
	MMI	6231	
	TI	SN74S288	
DM8599	AMD	AM27S03	
		DM8599	
	MMI	6561	
	TI	SN74S189	
DM86L97	Intersil	IM5623	
♦DM86L99	Fairchild	IM5501	
	Intersil	IM5501	
	MMI	L6561	
	National	**DM74LS189**	**743**
♦DM8600	Motorola	MC8300	
DM8601	AMD	9601	
	Fairchild	9601	
	Raytheon	RF8601	
	Signetics	N8T22	
	TI	SN29601	
DM8602	AMD	9602	
	Fairchild	9602	
	Raytheon	RF8602	
♦DM8640	National	DS8640	
	TI	SN74141	
DM8796	MMI	6241	
♦DM88XX	National	DS88XX	
♦DM8860	National	DS75491	
♦DM8862	National	DS75492	
DM8893	National	DS75493	
DM8894	National	DS75494	
DM9093	Motorola	MC853	
	Raytheon	RM993	
	SW	SW9093	
	TI	SN158093	
DM9094	Motorola	MC856	
	Raytheon	RM9094	
	SW	SW9094	
	TI	SN158094	
DM9097	Motorola	MC855	
	SW	SW9097	
	TI	SN158097	
DM9099	Motorola	MC852	
	Raytheon	RM999	
	SW	SW9099	
	TI	SN158099	
DM930	Motorola	MC830	
	Raytheon	RM930	
	SW	SW930	
	TI	SN15830	
DM9300	AMD	9300	
	Raytheon	RM9300	
	TI	SN29300	
DM9301	AMD	9301	
	TI	SN29301	
DM9312	AMD	9312	
	TI	SN29312	
DM932	Motorola	MC832	
	Raytheon	RM932	
	SW	SW932	
	TI	SN15838	
DM9322	AMD	9322	
DM9322	Raytheon	RM9322	
		54157	
	TI	SN29322	
DM933	Motorola	MC833	
	Raytheon	RM933	
	SW	SW933	
	TI	SN15833	
DM935	Motorola	MC840	
	Raytheon	RM935	
	SW	SW935	
	TI	SN15835	
DM936	Motorola	MC836	
	Raytheon	RM936	
	SW	SW936	
	TI	SN15836	
DM937	Motorola	MC837	
	Raytheon	RM937	
	SW	SW937	
	TI	SN15837	
DM944	Motorola	MC844	
	Raytheon	RM944	
	SW	SW944	
	TI	SN15844	
DM945	Motorola	MC845	
	Raytheon	RM945	
	SW	SW945	
	TI	SN15845	
DM946	Motorola	MC846	
	Raytheon	RM946	
	SW	SW946	
	TI	SN15846	
DM948	Motorola	MC848	
	Raytheon	RM948	
	SW	SW948	
	TI	SN15848	
DM949	Motorola	MC849	
	Raytheon	RM949	
	SW	SW949	
	TI	SN15849	
DM951	Motorola	MC851	
	Raytheon	RM951	
	TI	SN15851	
DM9567	Motorola	MC857	
DM957	Raytheon	RM957	
	SW	SW957	
	TI	SN15857	
DM958	Motorola	MC858	
	Raytheon	RM958	
	SW	SW958	
	TI	SN15858	
DM9601	AMD	9601	
	Raytheon	RF9601	
	TI	SN29601	
DM9602	AMD	9602	
	Raytheon	RF9602	
DM961	Motorola	MC861	
	Raytheon	RM961	
	SW	SW961	
	TI	SN15861	
DM962	Motorola	MC862	
	Raytheon	RM962	
	SW	SW962	
	TI	SN15862	
DM963	Motorola	MC863	
	Raytheon	RM963	
	SW	SW963	
	TI	SN15863	
DN74182	AMD	SN74182	
	Raytheon	74182	
	Signetics	74182	
	TI	SN74182	
DS0026	AMD	MH0026	
	Intersil	IM5013	
	Motorola	MMH0026	
DS1488	AMD	MC1488	
	Exar	XR1488	
	Harris	HD1488	
	ITT	ITT1488	
	Motorola	MC1488	
	Raytheon	RC1488	
	Signetics	MC1488	
DS1488	Silicon G	SG1488	
	TI	SN74188	
		SN75188	
DS1489	AMD	MC1489	
	Exar	XR1489	
	Harris	HD1489	
	ITT	ITT1489	
	Motorola	MC1489	
	Raytheon	RC1489	
	Signetics	MC1489	
	Silicon G	SG1489	
	TI	SN75189	
DS3611	Signetics	DS3611	
DS3612	Signetics	DS3612	
DS3613	Signetics	DS3613	
DS3614	Signetics	DS3614	
DS3650	Motorola	MC3450	
DS3651	Motorola	MC3430	
DS3652	Motorola	MC3452	
DS3653	Motorola	MC3432	
DS3674	Motorola	MC3460	
DS55107	AMD	SN55107	
	Fairchild	55107	
	Raytheon	RM55107	
	TI	SN55107	
DS55108	AMD	SN55108	
	Fairchild	55108	
	Raytheon	RM55108	
	TI	SN55108	
DS55109	AMD	SN55109	
	Fairchild	55109	
	Raytheon	RM55109	
	TI	SN55109	
DS55110	AMD	SN55110	
	Fairchild	55110	
	TI	SN55110	
DS55121	Fairchild	55121	
DS55122	Fairchild	55122	
DS5520	TI	SN5520	
DS5521	TI	SN5521	
DS5522	TI	SN5522	
DS5523	TI	SN5523	
DS5524	Fairchild	5524	
	TI	SN5524	
DS5525	Fairchild	5525	
	TI	SN5525	
DS5528	Fairchild	5528	
	TI	SN5528	
DS5529	Fairchild	5529	
	TI	SN5529	
DS55325	Raytheon	RM55325	
	TI	SN55325	
DS5534	Fairchild	5534	
	TI	SN5532	
DS5535	Fairchild	5535	
DS5538	Motorola	MC5538	
DS5539	Motorola	MC5539	
DS75107	AMD	SN75107	
	Fairchild	75107	
	ITT	ITT75107	
	Motorola	MC75107	
	Raytheon	RC75107	
	TI	SN75107	
DS75108	AMD	SN74108	
	Fairchild	75108	
	ITT	ITT75108	
	Motorola	MC75108	
	Raytheon	RC75108	
	TI	SN75108	
DS75109	AMD	SN75109	
	Fairchild	75109	
	ITT	ITT75109	
	Raytheon	RC75109	
	TI	SN75109	
DS75110	AMD	SN75110	
	Fairchild	75110	
	ITT	ITT75110	
	Motorola	MC75110	
	Raytheon	RC75110	
	TI	SN75110	
DS75121	Fairchild	75121	
DS75121	Motorola	MC8T13	
DS75122	Fairchild	75122	
	Motorola	MC8T14	
DS75123	Fairchild	75123	
DS75124	Fairchild	75124	
	Motorola	MC8T24	
DS75154	Fairchild	75154	
DS7520	ITT	ITT7520	
	Motorola	MC7520	
	Signetics	7520	
	Silicon G	SG7520	
	TI	SN7520	
DS75207	Fairchild	75207	
	TI	SN75207	
DS75208	Fairchild	75208	
	TI	SN75208	
DS7521	ITT	ITT7521	
	Signetics	7521	
	Silicon G	SG7521	
	TI	7521	
DS7522	ITT	ITT7522	
	Motorola	MC7522	
	Signetics	7522	
	Silicon G	SG7522	
	TI	SN7522	
DS7523	ITT	ITT7523	
	Motorola	MC7523	
	Signetics	7523	
	Silicon G	SG7523	
	TI	SN7523	
DS7524	Fairchild	7524	
	ITT	ITT7524	
	Motorola	MC7524	
	Signetics	7524	
	Silicon G	SG7524	
	TI	SN7524	
DS7525	Fairchild	7525	
	ITT	ITT7524	
	Motorola	MC7525	
	NPC	SFC2525	
	Signetics	7525	
	Silicon G	SG7525	
	TI	SN7525	
DS7528	Fairchild	7528	
	ITT	ITT7528	
	Motorola	MC7528	
	NPC	SFC2528	
	Silicon G	SG7528	
	TI	SN7528	
DS7529	Fairchild	7529	
	ITT	ITT7529	
	Motorola	MC7529	
	Silicon G	SG7529	
	TI	SN7529	
DS75324	Raytheon	RC75324	
	TI	SN75324	
DS75325	Fairchild	75325	
	ITT	ITT75325	
	Motorola	MC75325	
	Raytheon	RC75325	
	Silicon G	SG75325	
DS7534	Fairchild	7534	
	Motorola	MC7534	
	Silicon G	SG7534	
	TI	SN7534	
DS7535	Fairchild	7535	
	Motorola	MC7535	
	TI	SN7535	
DS75365	Motorola	MC75365	
DS7538	Motorola	MC7538	
	Silicon G	SG7538	
	TI	SN7538	
DS7539	Motorola	MC7539	
	Silicon G	SG7539	
	TI	SN7539	
DS75450	Fairchild	75450	
	Motorola	MC75450	
	Raytheon	RC75450	
	Signetics	75450	
	Silicon G	SG75450	
	TI	SN75450	

♦ Discontinued

Bold face device numbers indicate manufacturers' data is provided in the IC Master on the pages noted.

National Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
DS75451	Fairchild	75451	
	Motorola	MC75451	
	Raytheon	RC75451	
	Signetics	75451	
	Silicon G	SG75451	
	TI	SN75451	
DS75452	Fairchild	75452	
	Motorola	MC75452	
	Raytheon	RC75452	
	Signetics	75452	
	Silicon G	SG75452	
	TI	SN75452	
DS75453	Fairchild	75453	
	Motorola	MC75453	
	Raytheon	RC75453	
	Signetics	75453	
	TI	SN75453	
DS75454	Fairchild	75454	
	Motorola	MC75454	
	Raytheon	RC75454	
	Signetics	75454	
	Silicon G	SG75454	
	TI	SN75454	
DS75460	TI	SN75460	
DS75461	TI	SN75461	
DS75462	TI	SN75462	
DS75463	TI	SN75463	
DS75464	TI	SN75464	
DS75491	Fairchild	75491	
	Motorola	MC75491	
	TI	SN75491	
DS75492	Fairchild	75492	
	Motorola	MC75492	
	TI	SN75492	
DS7820	AMD	DM7820	
		DM7820	
	Signetics	DM7820	
	TI	SN55182	
DS7830	AMD	DM7830	
		DM7830	
	Signetics	DM7830	
	TI	SN55183	
DS7831	AMD	DM7831	
DS7832	AMD	DM7832	
DS8640	Signetics	SP380	
DS8820	AMD	DM8820	
		DM8820	
	Signetics	DM8820	
	TI	SN75182	
DS8830	AMD	DM8830	
		DM8830	
	Signetics	DM8830	
	TI	SN75183	
DS8831	AMD	DM8831	
DS8832	AMD	DM8832	
DS8837	Motorola	MC3437	
DS8838	Motorola	MC3438	
DS8880	Signetics	DM8880	
DS8889	Motorola	MC3491	
INS4001	Intel	4001	
INS4002	Intel	4002	
INS4003	Intel	4003	
INS4004	Intel	4004	
INS4008	Intel	4008	
INS4009	Intel	4009	
LF111	Fairchild	μAF111	
LF155	AMD	LF155	
	Fairchild	μAF155	
	Intersil	LF155	
	Motorola	LF155	
	TI	LF155	
LF156	AMD	LF156	
	Fairchild	μAF156	
	Intersil	LF156	
	Motorola	LF156	
	Raytheon	LF156	
	TI	LF156	
LF157	AMD	LF157	
	Fairchild	μAF157	
	Intersil	LF157	
	Motorola	LF157	
	TI	LF157	
LF211	Fairchild	μAF211	
LF255	AMD	LF255	
	Motorola	LF255	
	TI	LF255	
LF256	AMD	LF256	
	Motorola	LF256	
	Raytheon	LF256	
	TI	LF256	
LF257	AMD	LF257	
	Motorola	LF257	
	TI	LF257	
LF355	AMD	LF355	
	Fairchild	μAF355	
	Intersil	LF355	
	Motorola	LF355	
	TI	LF355	
LF356	AMD	LF356	
	Fairchild	μAF356	
	Intersil	LF356	
	Motorola	LF356	
	Raytheon	LF356	
LF357	AMD	LF357	
	Fairchild	μAF357	
	Intersil	LF357	
	Motorola	LF387	
	TI	LF357	
LF398	Datel	SHM-LM-2	
LH0021	Beckman	833-21	
LH0042	AD	AD0042	
	Intersil	LH0042	
LH0062	**AD**	**AD528**	**574**
LH201	Siliconix	LH201	
LH2101	AMD	LH2101	
	Intersil	LH2101	
LH2108	Intersil	LH2108	
LH2110	Intersil	LH2110	
LH2111	AMD	LH2111	
	Intersil	LH2111	
LH2301	AMD	LH2301	
	Intersil	LH2301	
LH2308	Intersil	LH2308	
LH2310	Intersil	LH2310	
LH2311	AMD	LH2311	
	Intersil	LH2311	
LH740	Fairchild	μA740	
	Intersil	LH740	
	Signetics	μA740	
LM0052	**AD**	**AD506**	**574**
LM100	Intersil	LM100	
	NPC	SFC2100	
	Silicon G	SG100	
LM101	**AD**	**AD101**	**575**
	AMD	LM101	
	Fairchild	μA101	
	Intersil	LM101	
	Motorola	MLM101	
	NPC	SFC2101	
	RCA	CA101	
		CA748	
	Signetics	LM101	
	Silicon G	SG101	
	Siliconix	LM101	
	Teledyne S	LM101	
	TI	LM101	
LM102	AMD	LM102	
	Fairchild	μA102	
	Intersil	LM102	
	Motorola	MLM110	
	Silicon G	SG102	
LM104	Fairchild	μA104	
	Motorola	MLM104	
	NPC	SFC2104	
	Raytheon	LM104	
	Silicon G	SG104	
	Teledyne S	LM104	
	TI	LM104	
LM105	AMD	LM105	
	Fairchild	μA105	
	Intersil	LM105	
	Motorola	MLM105	
	NPC	SFC2105	
	Raytheon	LM105	
	Silicon G	SG105	
	Teledyne S	LM105	
	TI	LM105	
LM106	AMD	LM106	
	Raytheon	LM106	
	TI	LM106	
LM107	**AD**	**AD741S**	**575**
	AMD	LM107	
	Fairchild	μA107	
	Intersil	LM107	
	Motorola	MLM107	
	NPC	SFC2107	
	Raytheon	LM107	
	RCA	CA107	
	Signetics	LM107	
	Silicon G	SG107	
	TI	LM107	
LM108	**AD**	**AD108**	**575**
	AMD	LM108	
	Fairchild	μA108	
	Intersil	LM108	
	Motorola	MLM108	
	PMI	PM108	
	Raytheon	LM108	
	RCA	CA108	
	Signetics	LM108	
	Silicon G	SG108	
LM109	Fairchild	μA109	
	Motorola	MLM109	
	NPC	SFC2109	
	Raytheon	LM109	
	Signetics	LM109	
	Silicon G	SG109	
	TI	LM109	
LM110	AMD	LM110	
	Fairchild	μA110	
	Intersil	LM110	
	Motorola	MLM110	
	Silicon G	SG110	
LM111	AMD	LM111	
	Fairchild	μA111	
	Intersil	LM111	
	Motorola	MLM111	
	NPC	SFC2111	
	Raytheon	LM111	
	RCA	CA111	
	Signetics	LM111	
	Silicon G	SG111	
	Teledyne S	LM111	
	TI	LM111	
LM112	AMD	LM112	
	Raytheon	LM112	
	Silicon G	SG1118	
LM118	**AD**	**AD518**	**574**
	AMD	LM118	
	Raytheon	LM118	
	TI	LM118	
LM119	AMD	LM119	
LM120	Silicon G	SG120	
LM123	Motorola	LM123	
	Silicon G	SG123	
LM124	AMD	LM124	
	Fairchild	μA124	
	Intersil	LM124	
	Motorola	MLM124	
	Raytheon	LM124	
	RCA	CA124	
	Signetics	LM124	
	Silicon G	SG124	
	TI	LM124	
LM1303	Raytheon	RC4739	
LM1304	Fairchild	μA732	
	Sprague	ULN-2120	
LM1305	Sprague	ULN-2122	
LM1307	Fairchild	μA767	
LM1307	Sprague	ULN-2128	
LM1310	Exar	XR1310	
	Motorola	MC1310	
	RCA	CA1310	
	Sprague	ULN-2210	
LM1351	Motorola	MC1351	
LM139	AMD	LM139	
	Fairchild	μA139	
	Motorola	MLM139	
	Raytheon	LM139	
	RCA	CA139	
	Signetics	LM139	
	Silicon G	SG139	
	Teledyne S	LM139	
	TI	LM139	
LM1391	Motorola	MC1391	
LM1394	Motorola	MC1394	
LM140-05	Silicon G	SG140-05	
LM140-06	Silicon G	SG140-06	
LM140-08	Silicon G	SG140-08	
LM140-12	Silicon G	SG140-12	
LM140-15	Silicon G	SG140-15	
LM140-18	Silicon G	SG140-18	
LM140-24	Silicon G	SG140-24	
LM1414	Motorola	MC1414	
	Raytheon	RC1414	
	TI	TL514	
LM1458	AMD	1458	
	Fairchild	μA1458	
	Harris	**HA-2655**	**580**
	Motorola	MC1458	
	PMI	OP-14	
		SSS1458	
	Raytheon	RC1458	
		RC4558	
	RCA	CA1458	
	Signetics	MC1458	
	Silicon G	SG1458	
	Teledyne S	1458	
	TI	MC1458	
LM148	AMD	LM148	
	Harris	**HA-4741**	**580**
	Intersil	LM148	
	Motorola	MC4741	
		MC4741	
	Raytheon	LM148	
LM1488	National	DS1488	
LM1489	National	DS1489	
LM149	Intersil	LM149	
LM1496	Fairchild	μA796	
	Lithic Sys	LS1496	
	Motorola	MC1496	
	Signetics	MC1496	
	Silicon G	SG1496	
LM1514	Motorola	MC1514	
	Raytheon	RM1514	
	TI	TL514	
LM1558	AMD	1558	
	Fairchild	μA1558	
	Harris	**HA-2650**	**581**
	Motorola	MC1558	
	PMI	PM1558	
		SSS1558	
	Raytheon	RM1558	
	RCA	CA1558	
	Signetics	MC1558	
	Silicon G	SG1558	
	Teledyne S	1558	
	TI	MC1558	
LM158	Motorola	MLM158	
	Raytheon	LM158	
		RM4139	
	Signetics	SE532	
	TI	LM158	
LM1596	Lithic Sys	LS1596	
	Motorola	MC1596	
	Signetics	MC1596	
	Silicon G	SG1596	
LM160	Fairchild	μA760	
LM1611	National	DS1611	
LM1612	National	DS1612	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

National Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
LM1613	National	DS1613	
LM1614	National	DS1614	
LM163	**National**	**DS1603**	**475**
LM163A	National	DS1604	
LM170	Lithic Sys	LS170	
LM171	Lithic Sys	LS171	
LM1800	Exar	XR1800	
	Fairchild	μA758	
	RCA	CA758	
	Sprague	ULN-2244	
LM1820	Fairchild	μA720	
	Sprague	ULN-2137	
LM1829	Fairchild	μA787	
LM1841	Fairchild	μA2136	
	Motorola	MC1356	
	Sprague	ULN-2136	
LM193	Signetics	LM193	
LM200	Intersil	LM200	
	NPC	SFC2200	
	Silicon G	SG200	
LM201	**AD**	**AD201**	**575**
	AMD	LM201	
	Fairchild	μA201	
	Intersil	LM201	
	Motorola	MLM201	
	NPC	SFC2201	
	RCA	CA201	
		CA748	
	Signetics	LM201	
	Silicon G	SG201	
	Teledyne S	LM201	
	TI	LM201	
LM202	AMD	LM202	
	Fairchild	μA202	
	Intersil	LM202	
	Motorola	MLM210	
	Silicon G	SG202	
LM204	Fairchild	μA204	
	Motorola	MLM204	
	NPC	SFC2204	
	Raytheon	LM204	
	Silicon G	SG204	
	Teledyne S	LM204	
	TI	LM204	
LM205	AMD	LM205	
	Fairchild	μA205	
	Intersil	LM205	
	Motorola	MLM205	
	NPC	SFC2205	
	Raytheon	LM205	
	Silicon G	SG205	
	Teledyne S	LM205	
	TI	LM205	
LM206	AMD	LM206	
	TI	LM206	
LM207	**AD**	**AD741J**	**575**
	AMD	LM207	
	Fairchild	μA207	
	Intersil	LM207	
	Motorola	MLM207	
	NPC	SFC2207	
	Raytheon	LM207	
	RCA	CA207	
	Signetics	LM207	
	Silicon G	SG207	
	TI	LM207	
LM208	**AD**	**AD208**	**575**
	AMD	LM208	
	Fairchild	μA208	
	Intersil	LM208	
	Motorola	MLM208	
	PMI	PM208	
	Raytheon	LM208	
	RCA	CA208	
	Signetics	LM208	
	Silicon G	SG208	
LM209	Fairchild	μA209	
LM209	Motorola	MLM209	
	NPC	SFC2209	
	Raytheon	LM209	
	Signetics	LM209	
	Silicon G	SG209	
	TI	LM209	
LM210	AMD	LM210	
	Fairchild	μA210	
	Intersil	LM210	
	Motorola	MLM210	
	Silicon G	SG210	
LM211	AMD	LM211	
	Fairchild	μA211	
	Intersil	LM211	
	Motorola	MLM211	
	NPC	SFC2211	
	Raytheon	LM211	
	RCA	CA211	
	Signetics	LM211	
	Silicon G	SG211	
	Teledyne S	LM211	
	TI	LM211	
LM2111	Motorola	MC1357	
	RCA	CA2111	
	Signetics	ULN2111	
	Sprague	ULN-2111	
LM2113	Sprague	ULN-2113	
LM212	AMD	LM212	
	Raytheon	LM212	
LM216	AMD	LM216	
LM218	**AD**	**AD518**	**574**
	AMD	LM218	
	Raytheon	LM218	
	TI	LM218	
LM224	AMD	LM224	
	Intersil	LM224	
	Motorola	MLM224	
	Raytheon	LM224	
	RCA	CA224	
	Signetics	LM224	
	Silicon G	SG224	
	TI	LM224	
LM239	AMD	LM239	
	Motorola	MC3302	
		MLM239	
	Raytheon	LM239	
	RCA	CA239	
	Signetics	LM239	
	Silicon G	SG239	
	Teledyne S	LM239	
	TI	LM239	
LM248	AMD	LM248	
	Intersil	LM248	
	Motorola	MC4741	
	Raytheon	LM248	
LM249	Intersil	LM249	
LM258	Motorola	MLM258	
	Raytheon	LM258	
	Signetics	LM258	
	TI	LM258	
LM270	Lithic Sys	LS270	
LM271	Lithic Sys	LS271	
LM2900	Fairchild	μA2900	
	Motorola	MLM2900	
	Raytheon	LM2900	
LM2901	Fairchild	μA2901	
	Motorola	MLM2901	
	Raytheon	LM2901	
	Teledyne S	LM2901	
	TI	LM2901	
LM2902	Fairchild	μA2902	
	Motorola	MLM2902	
	Raytheon	LM2902	
	TI	LM2902	
LM293	Signetics	LM293	
LM300	Intersil	LM300	
	NPC	SFC2300	
	Silicon G	SG300	
LM301	**AD**	**AD301**	**575**
	AMD	LM301	
	Fairchild	μA301	
LM301	Intersil	LM301	
	Motorola	MLM301	
	NPC	SFC2301	
	Raytheon	LM301	
	RCA	CA301	
	Signetics	LM301	
	Silicon G	SG301	
	Teledyne S	LM301	
	TI	LM301	
LM3018	Fairchild	μA3018	
	Lithic Sys	LA3018	
LM3019	Fairchild	μA3019	
LM302	AMD	LM302	
	Fairchild	μA302	
	Intersil	LM302	
	Motorola	MC7912	
		MLM310	
	Silicon G	SG302	
LM3026	Fairchild	μA3026	
LM3028	Lithic Sys	LS3028	
LM304	Fairchild	μA304	
	Motorola	MLM304	
	NPC	SFC2304	
	Raytheon	LM304	
	Silicon G	SG304	
	Teledyne S	LM304	
	TI	LM304	
LM3045	Fairchild	μA3045	
	Silicon G	SG3045	
LM3046	Fairchild	μA3046	
	Motorola	MC3346	
	Silicon G	SG3046	
LM305	AMD	LM305	
	Fairchild	μA305	
	Intersil	LM305	
	Motorola	MLM305	
	NPC	SFC2305	
	Raytheon	LM305	
	Silicon G	SG305	
	Teledyne S	LM305	
	TI	LM305	
LM3053	Fairchild	μA753	
	Lithic Sys	LS3053	
LM3054	Fairchild	μA3054	
	Motorola	CA3054	
LM306	AMD	LM306	
	Raytheon	LM306	
	TI	LM306	
LM3064	Fairchild	μA3064	
	Motorola	MC1364	
	Sprague	ULN-2264	
LM3065	Fairchild	μA3065	
	Motorola	MC1358	
♦LM3066	Fairchild	μA3066	
LM3067	Fairchild	μA3067	
LM307	**AD**	**AD741J**	**575**
	AMD	LM307	
	Fairchild	μA307	
	Intersil	LM307	
	Motorola	MLM307	
	NPC	SFC2307	
	Raytheon	LM307	
	RCA	CA307	
	Signetics	LM307	
	Silicon G	SG307	
	TI	LM307	
LM3070	Fairchild	μA780	
	Sprague	ULN-2124	
LM3071	Sprague	ULN-2127	
LM3075	Fairchild	μA3075	
	Motorola	MC1375	
	Sprague	ULN-2129	
LM308	**AD**	**AD308**	**575**
	AMD	LM308	
	Fairchild	μA308	
	Intersil	LM308	
	Motorola	MLM308	
	PMI	PM308	
	Raytheon	LM308	
	RCA	CA308	
	Signetics	LM308	
LM308	Silicon G	SG308	
LM3086	Fairchild	μA3086	
	Motorola	MC3386	
LM309	Fairchild	μA309	
	Motorola	MLM309	
	NPC	SFC2309	
	Raytheon	LM309	
	Signetics	LM309	
	Silicon G	SG309	
	TI	LM309	
LM310	AMD	LM310	
	Fairchild	μA310	
	Intersil	LM310	
	Motorola	MLM310	
	Silicon G	SG310	
LM311	AMD	LM311	
	Fairchild	μA311	
	Intersil	LM311	
	Motorola	MLM311	
	NPC	SFC2311	
	Raytheon	LM311	
	RCA	CA311	
	Signetics	LM311	
	Silicon G	SG311	
	Teledyne S	LM311	
	TI	LM311	
LM312	AMD	LM312	
	Raytheon	LM312	
LM316	AMD	LM316	
LM317	Motorola	LM317	
LM318	**AD**	**AD518**	**574**
	AMD	LM318	
	Raytheon	LM318	
	TI	LM318	
LM319	AMD	LM319	
LM320	Motorola	MC7905	
	Silicon G	SG320	
LM320-05	Motorola	MC7905	
	Silicon G	SG320-05	
LM320-12	Motorola	MC7912	
	Silicon G	SG320-12	
LM323	Fairchild	SH0323	
	Motorola	LM323	
	Silicon G	SG323	
LM324	AMD	LM324	
	Fairchild	μA324	
	Motorola	MLM324	
	Raytheon	LM324	
	RCA	CA324	
	Signetics	LM324	
	Silicon G	SG324	
	TI	LM324	
LM3301	Motorola	MC3301	
LM3302	Motorola	MC3302	
	Silicon G	SG3302	
LM339	AMD	LM339	
	Fairchild	μA339	
	Motorola	MC3302	
		MLM339	
	Raytheon	LM339	
	RCA	CA339	
	Signetics	LM339	
	Silicon G	SG339	
	Teledyne S	LM339	
	TI	LM339	
LM340-12	Fairchild	μA7812	
	Motorola	MC7812	
	Raytheon	RC7812	
	Silicon G	SG340-12	
	TI	μA7812	
LM340-15	Fairchild	μA7815	
	Motorola	MC7815	
	Signetics	μA7815	
	Silicon G	SG340-15	
	TI	μA7815	
LM340-18	Fairchild	μA7818	
	Motorola	MC7818	
	Raytheon	RC7818	
	Signetics	μA7818	
	Silicon G	SG340-18	
	TI	μA7818	

♦ Discontinued

Bold face device numbers indicate manufacturers' data is provided in the IC Master on the pages noted.

National Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
LM340-24	Fairchild	μA7824	
	Motorola	MC7824	
	Raytheon	RC7824	
	Signetics	μA7824	
	Silicon G	SG340-24	
	TI	μA7824	
LM340-5	Fairchild	μA7805	
	Motorola	MC7805	
	Raytheon	RC7805	
	Signetics	μA7805	
	Silicon G	SG340-05	
	TI	μA7805	
LM340-6	Fairchild	μA7806	
	Motorola	MC7806	
	Raytheon	RC7806	
	Signetics	μA7806	
	Silicon G	SG340-06	
LM340-8	Fairchild	μA7808	
	Motorola	MC7808	
	Raytheon	RC7808	
	Signetics	μA7808	
	Silicon G	SG340-08	
	TI	μA7808	
LM3401	Motorola	MC3401	
LM343	Motorola	MC1439	
LM348	AMD	LM348	
	Harris	**HA-4741**	**580**
	Motorola	MC4741	
		MC4741	
	Raytheon	LM348	
LM350	National	DS350	
LM351	National	DS75453	
LM354	NPC	SFC2524	
		SFC2525	
LM358	Motorola	MLM358	
	Raytheon	LM358	
		RC4139	
	Signetics	LM358	
	TI	LM358	
♦LM360	Fairchild	μA760	
LM3611	Sprague	ULN-3611	
♦LM3612	National	DS3612	
	Sprague	ULN-3612	
♦LM3613	National	DS3613	
	Sprague	ULN-3613	
♦LM3614	National	DS3614	
	Sprague	ULN-3614	
♦LM3625	**National**	**DS3625**	**485**
♦LM363	**National**	**DS3603**	**475**
♦LM363A	**National**	**DS3604**	**475**
♦LM367	Silicon G	SG305	
♦LM370	Lithic Sys	LS370	
LM371	Lithic Sys	LS371	
♦LM376	Fairchild	μA376	
	NPC	SFC2376	
	Teledyne S	LM376	
	TI	LM376	
LM377	Sprague	ULN-2278	
LM380	Sprague	ULN-2280	
LM381	Fairchild	μA739	
LM3900	Fairchild	μA3900	
	Motorola	MC3401	
	Raytheon	RC3302	
♦LM3901	Motorola	MC3302	
	Raytheon	MC3302	
LM3909	Lithic Sys	LS3909	
	Siliconix	**LM3909**	**604**
LM393	Signetics	LM393	
LM4250	Fairchild	μA776	
	Harris	**HA-2720**	**581**
	Intersil	LM4250	
	Silicon G	SG4250	
	Solitron	UC4250	
LM55107A	**National**	**DS55107**	**475**
LM55108A	**National**	**DS55108**	**475**
LM5520	National	DS5520	
LM5521	National	DS5521	
LM5522	National	DS5522	
LM5523	National	DS5523	
LM5524	National	DS5524	
LM5525	National	DS5525	
LM5528	National	DS5528	
LM5529	National	DS5529	
LM55325	**National**	**DS55325**	**495**
LM5534	National	DS5534	
LM5535	National	DS5535	
♦LM5538	National	DS5538	
LM5539	National	DS5539	
LM55450	National	DS55450	
LM55451	National	DS55451	
LM55452	National	DS55452	
LM55454	National	DS55454	
LM555	Exar	XR555	
	Fairchild	μA555	
	Intersil	LM555	
	Lithic Sys	LS555	
	Motorola	MC1455	
		MC1555	
	Raytheon	RC555	
		RM555	
	RCA	CA555	
	Signetics	NE555	
	Silicon G	SG555	
	TI	NE555	
		SE555	
LM556	Fairchild	μA556	
	Motorola	MC3456	
		MC3556	
	Silicon G	SG556	
	TI	NE556	
		SE556	
LM565	Motorola	MLM565	
	Signetics	NE565	
LM566	Signetics	NE566	
LM567	Exar	XR567	
	Signetics	NE567	
LM703	Fairchild	μA703	
LM709	Fairchild	μA709	
	Motorola	MC1709	
	NPC	SFC2709	
	Raytheon	RC709	
		RM709	
	Signetics	μA709	
	Teledyne S	709	
	TI	μA709	
LM710	Fairchild	μA710	
	Motorola	MC1710	
	NPC	SFC2710	
	Raytheon	RC710	
		RM710	
	RCA	CA710	
	Signetics	μA710	
	Silicon G	SG710	
	Teledyne S	710	
	TI	μA710	
LM711	Fairchild	μA711	
	Motorola	MC1711	
	NPC	SFC2711	
	Raytheon	RC711	
		RM711	
	RCA	CA711	
	Signetics	μA711	
	Silicon G	SG711	
	Teledyne S	711	
	TI	μA711	
LM723	AMD	723	
	Fairchild	μA723	
	Intersil	723	
	Motorola	MC1723	
	NPC	SFC2723	
	Raytheon	RC723	
		RM723	
	RCA	CA723	
	SGS	L123	
	Signetics	μA723	
	Silicon G	SG723	
	Teledyne S	723	
	TI	μA723	
LM725	AMD	725	
	Fairchild	μA725	
	Intersil	SSS725	
	PMI	SSS725	
	Raytheon	RC725	
		RM725	
LM733	AMD	733	
	Fairchild	μA733	
	Motorola	MC1733	
	Raytheon	RC733	
		RM733	
	Signetics	μA733	
	Silicon G	SG733	
	TI	μA733	
LM741	**AD**	**AD741**	**575**
	AMD	741	
	Fairchild	μA741	
	Intersil	SSS741	
		741	
	Motorola	MC1741	
	NPC	SFC2741	
	PMI	OP-02	
		PM741	
		SSS741	
	Raytheon	RC741	
		RM741	
	RCA	CA741	
	Signetics	μA741	
	Silicon G	SG741	
	Teledyne S	741	
	TI	μA741	
LM746	Motorola	MC1328	
	Sprague	ULN-2114	
		ULN-2228	
LM747	AMD	747	
	Fairchild	μA747	
	Intersil	SSS747	
	Motorola	MC1747	
	PMI	OP-04	
		PM747	
		SSS747	
	Raytheon	RC747	
		RM747	
	RCA	CA747	
	Signetics	μA747	
	Silicon G	SG747	
	Teledyne S	747	
	TI	μA747	
LM748	AMD	748	
	Fairchild	μA748	
	Intersil	748	
	Motorola	MC1748	
	NPC	SFC2748	
	Raytheon	RC748	
		RM748	
	RCA	CA748	
	Signetics	μA748	
	Silicon G	SG748	
	Teledyne S	748	
	TI	μA748	
LM75107A	**National**	**DS75107**	**475**
LM75108A	**National**	**DS75108**	**475**
LM7520	National	DS7520	
LM7521	National	DS7521	
LM7522	National	DS7522	
LM7523	National	DS7523	
LM7524	National	DS7524	
LM7525	National	DS7525	
LM7528	National	DS7528	
LM7529	National	DS7529	
LM75324	**National**	**DS75324**	**497**
LM75325	**National**	**DS75325**	**495**
LM7534	National	DS7534	
LM7535	National	DS7535	
LM7538	National	DS7538	
LM7539	National	DS7539	
LM75450	National	DS75450	
LM75451	National	DS75451	
LM75452	National	DS75452	
LM75454	National	DS75454	
LM78L05	Motorola	MC78L05	
LM78L05	Silicon G	SG7805	
	TI	μA78L05	
LM78L08	Motorola	MC78L08	
	Silicon G	SG7808	
	TI	μA78L08	
LM78L12	Motorola	MC78L12	
	Silicon G	SG7812	
	TI	μA78L12	
LM78L15	Motorola	MC78L15	
	Silicon G	SG7815	
	TI	μA78L15	
LM78L18	Harris	SG7818	
	Motorola	MC78L18	
	Silicon G	SG7818	
LM78L24	Harris	SG7824	
	Motorola	MC78L24	
	Silicon G	SG7824	
LM7805	Motorola	MC7805	
	Signetics	μA7805	
	Silicon G	SG7805	
	TI	μA7805	
LM7806	Motorola	MC7806	
	Signetics	μA7806	
	Silicon G	SG7806	
LM7808	Motorola	MC7808	
	Signetics	μA7808	
	TI	μA7808	
LM7812	Motorola	MC7812	
	Signetics	μA7812	
	Silicon G	SG7812	
	TI	μA7812	
LM7815	Motorola	MC7815	
	Signetics	μA7815	
	Silicon G	SG7815	
	TI	μA7815	
LM7818	Motorola	MC7818	
	Signetics	μA7818	
	Silicon G	SG7818	
	TI	μA7818	
		μA7918	
LM7824	Motorola	MC7824	
	Signetics	μA7824	
	Silicon G	SG7824	
	TI	μA7824	
LM7905	TI	μA7905	
LM7906	TI	μA7906	
LM7908	TI	μA7908	
LM7912	TI	μA7912	
LM7915	TI	μA7915	
LM7924	TI	μA7924	
MH0013	Intersil	IM5013	
MH0025	**National**	**DS0025**	**473**
MH0026	**National**	**DS0026**	**474**
MH0056	**National**	**DS0056**	**474**
MH7803	**National**	**DS7803**	**490**
MH8803	**National**	**DS8803**	**490**
MH8808	National	DS8808	
MM1101	AMD	1101	
	Intersil	IM7501	
		IM7511	
		IM7512	
	Mostek	MK4007	
MM1103	Signetics	1103	
	TI	TMS1103	
MM1402	AMD	1402	
	SGS	M141	
	Signetics	1402	
		2502	
	Synertek	SY1402	
MM1403	AMD	1403	
	AMI	S2503	
	SGS	M136	
	Signetics	2503	
	Synertek	SY1403	
MM1404	AMD	1404	
	AMI	S2504	
	SGS	M130	
	Signetics	2504	
	Synertek	SY1404	
MM1702A	Mostek	MK3702	
MM2101	RCA	MW4101	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

National Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
MM2102	Mostek	MK4102	
	Signetics	2102	
	TI	TMS4035	
MM2111	RCA	MW4111	
MM2112	RCA	MW4112	
MM2521	AMD	AM2521	
	Signetics	2521	
MM2522	Signetics	2522	
MM2533	AMD	AM2533	
	Signetics	2533	
MM4232	Mostek	MK2500	
MM4240	AMI	S8614	
MM452	Siliconix	SI452	
MM455	Siliconix	SI455	
♦MM46XX	National	CD40XX	
♦MM5013	AMI	S2512A	
	Signetics	2512	
		2525	
MM5016	AMI	S1865	
♦MM5020	Intersil	IM7780	
MM5025	Synertek	SY5025	
MM5026	Synertek	SY5026	
MM5027	Synertek	SY5027	
MM5054	AMI	S2181	
MM5055	AMD	5055	
MM5057	AMD	5057	
MM5058	TI	TMS3133	
MM506	Signetics	2506	
MM5060	AMI	S2181	
MM5066	AMD	5056	
MM507	Signetics	2517	
MM5230	Motorola	MCM1112	
MM5231	**AMI**	**S5232**	**650**
MM5232	Mostek	MK2500	
		MK2600	
MM5233	**AMI**	**S3514**	**650**
MM5257	Mostek	MK4104	
MM5262	Nortec	6003	
MM5264	Nortec	6003	
MM5280	Intersil	7280	
	RCA	MW4060	
	Signetics	2680	
MM5303	GI	AY3-1014	
		AY3-1015	
		AY5-1013	
MM5316	AMI	S1998	
MM5387	AMI	S1998	
MM54C00	Harris	HD54C00	
MM54C02	Harris	HD54C02	
MM54C04	Harris	HD54C04	
MM54C08	Harris	HD54C08	
MM54C10	Harris	HD54C10	
MM54C107	Harris	HD54C107	
MM54C14	Harris	HD54C14	
MM54C151	Harris	HD54C151	
MM54C154	Harris	HD54C154	
MM54C157	Harris	HD54C157	
MM54C160	Harris	HD54C160	
MM54C161	Harris	HD54C161	
MM54C162	Harris	HD54C162	
MM54C163	Harris	HD54C163	
MM54C164	Harris	HD54C164	
MM54C165	Harris	HD54C165	
MM54C173	Harris	HD54C173	
MM54C174	Harris	HD54C174	
MM54C175	Harris	HD54C175	
MM54C192	Harris	HD54C192	
MM54C193	Harris	HD54C193	
MM54C195	Harris	HD54C195	
MM54C20	Harris	HD54C20	
MM54C200	Harris	HD54C200	
MM54C221	Harris	HD54C221	
MM54C30	Harris	HD54C30	
MM54C32	Harris	HD54C32	
MM54C42	Harris	HD54C42	
MM54C48	Harris	HD54C48	
MM54C73	Harris	HD54C73	
MM54C74	Harris	HD54C74	
MM54C76	Harris	HD54C76	
MM54C83	Harris	HD54C83	
MM54C85	Harris	HD54C85	
MM54C86	Harris	HD54C86	
MM54C90	Harris	HD54C90	
MM54C901	Harris	HD54C901	
MM54C902	Harris	HD54C902	
MM54C903	Harris	HD54C903	
MM54C904	Harris	HD54C904	
MM54C906	Harris	HD54C906	
MM54C907	Harris	HD54C907	
MM54C914	Harris	HD54C914	
MM54C922	Harris	HD54C922	
MM54C923	Harris	HD54C923	
MM54C925	Harris	HD54C925	
MM54C926	Harris	HD54C926	
MM54C927	Harris	HD54C927	
MM54C928	Harris	HD54C928	
MM54C93	Harris	HD54C93	
MM54C95	Harris	HD54C95	
MM551	AMI	MX52D	
MM552	Siliconix	SI552	
MM555	Siliconix	SI555	
MM5555	Nitron	NCM1183	
MM5556	Nitron	NC1184	
MM5823	GI	AY1-2006	
MM5824	GI	AY1-1006	
MM70C95	Harris	HD70C95	
MM70C97	Harris	HD70C97	
MM74C00	Harris	HD74C00	
	RCA	CD4011	
MM74C02	Harris	HD74C02	
	RCA	CD4001	
MM74C04	Harris	HD74C04	
	RCA	CD4069	
	SSS	SCL4069	
MM74C08	Harris	HD74C08	
	RCA	CD4081	
MM74C10	Harris	HD74C10	
	RCA	CD4023	
MM74C107	Harris	HD74C107	
MM74C14	Harris	HD74C14	
	Motorola	MC14584	
MM74C151	Harris	HD74C151	
	Teledyne S	MM74C151	
MM74C154	Harris	HD74C154	
MM74C160	Fairchild	F40160	
	Harris	HD74C160	
MM74C161	Fairchild	F40161	
	Harris	HD74C161	
	SSS	SCL4160	
MM74C162	Fairchild	F40162	
	Harris	HD74C162	
MM74C163	Fairchild	F40163	
	Harris	HD74C163	
MM74C164	Harris	HD74C164	
MM74C165	Harris	HD74C165	
MM74C173	Harris	HD74C173	
	RCA	CD4076	
MM74C174	Fairchild	F40174	
	Harris	HD74C174	
MM74C175	Fairchild	F40175	
	Harris	HD74C175	
MM74C192	Fairchild	F40192	
	Harris	HD74C192	
	RCA	CD40192	
MM74C193	Fairchild	F40193	
	Harris	HD74C193	
	RCA	CD40193	
MM74C195	Fairchild	F40195	
	Harris	HD74C195	
MM74C20	Harris	HD74C20	
	RCA	CD4012	
MM74C200	Harris	HD74C200	
	RCA	CD4061	
MM74C221	Harris	HD74C221	
	RCA	CD4098	
MM74C30	Harris	HD74C30	
	RCA	CD4068	
MM74C32	Harris	HD74C32	
MM74C32	RCA	CD4071	
MM74C42	Harris	HD74C42	
	RCA	CD4028	
MM74C48	Harris	HD74C48	
MM74C73	Harris	HD74C73	
MM74C74	RCA	CD4013	
MM74C76	Harris	HD74C76	
	RCA	CD4027	
MM74C83	Harris	HD74C83	
	RCA	CD4008	
MM74C85	Fairchild	F40085	
	Harris	HD74C85	
	RCA	CD4063	
	SSS	SCL4585	
MM74C86	Harris	HD74C86	
	RCA	CD4030	
		CD4070	
MM74C89	Harris	HD74C89	
MM74C90	Harris	HD74C90	
MM74C901	Harris	HD74C901	
MM74C902	Harris	HD74C902	
MM74C903	Harris	HD74C903	
MM74C904	Harris	HD74C904	
MM74C906	Harris	HD74C906	
MM74C907	Harris	HD74C907	
MM74C914	Harris	HD74C914	
MM74C922	Harris	HD74C922	
MM74C923	Harris	HD74C923	
MM74C925	Harris	HD74C925	
MM74C926	Harris	HD74C926	
MM74C927	Harris	HD74C927	
MM74C928	Harris	HD74C928	
MM74C93	Harris	HD74C93	
MM74C95	Harris	HD74C95	
MM74S157	Harris	HD74C157	
MM74162	SSS	SCL4162	
MM74163	SSS	SCL4163	
MM80C95	Harris	HD80C95	
MM80C97	Fairchild	F40097	
	Harris	HD80C97	
MM80C98	Fairchild	F40098	
♦NH00011	Fairchild	SH2001	
		SH2002	
♦NH00016	Fairchild	SH2200	
♦NH00017	Fairchild	SH2200	
♦NH00018	Fairchild	SH2200	
NN74C74	Harris	HD74C74	
♦SM3611	National	DS3611	

NEC Microcomputers

μPD411	RCA	MW4060
μPD414	Mostek	MK4096
μPD416	Mostek	MK4116

Nitron

♦NCM1110	Motorola	MCM1110
	National	MM5231
	Signetics	2430
	TI	TMS2600
♦NCM1111	Motorola	MCM1111
	Signetics	2461
♦NCM1112	Motorola	MCM1112
	National	MM5230
♦NCM1120	Motorola	MCM1120
	TI	TMS2400
♦NCM1121	Motorola	MCM1121
♦NCM1122	Motorola	MCM1122
♦NCM1130	Motorola	MCM1130
	TI	TMS4100
♦NCM1131	Motorola	MCM1131
♦NCM1140	Motorola	MCM1140
	TI	TMS4300
NC1181	AMI	S2567
NC1182	AMI	S2566
NC1183	AMI	S2555
	National	MM5555
NC1184	AMI	S2556
NC1184	National	MM5556
NC2259	Motorola	MC2259
NC2260	Motorola	MC2260
NC2557	Motorola	MC2257
NC4104A	**EMM/Semi**	**4104A**	**667**
NC4200	**EMM/Semi**	**4200**	**671**
NC4402A	EMM/Semi	4402A	
NC4402B	EMM/Semi	4402B	
NC4801A	EMM/Semi	4801A	
NC4804A	**EMM/Semi**	**4804A**	**663**
NC6560	Motorola	MCM6560	
NC6561	Motorola	MCM6561	
NC6570	Motorola	MCM6570	
NC6571	Motorola	MCM6571	
NC6572	Motorola	MCM6572	
NC6580	Motorola	MCM6580	
NC6581	Motorola	MCM6581	
NC6583	Motorola	MCM6583	
NC6590	Motorola	MCM6590	
NC6832	Motorola	MCM6832	

Nortec Electronics

2222	**AMI**	**S2222**	**634**
6002	TI	TMS4062	
		TMS6002	
6003	TI	TMS4063	
7001	RCA	MW7001	

Plessey Semiconductors

SL3045	RCA	CA3045
SL3046	RCA	CA3046
SL3086	RCA	CA3086
SP1001	Motorola	MC1001
SP1004	Motorola	MC1004
SP1006	Motorola	MC1006
SP1007	Motorola	MC1007
SP1010	Motorola	MC1010
SP1011	Motorola	MC1011
SP1012	Motorola	MC1012
SP1013	Motorola	MC1013
SP1014	Motorola	MC1014
SP1015	Motorola	MC1015
SP1016	Motorola	MC1016
SP1020	Motorola	MC1020
SP1023	Motorola	MC1023
SP1026	Motorola	MC1026
SP1027	Motorola	MC1027
SP1030	Motorola	MC1030
SP1031	Motorola	MC1031
SP1032	Motorola	MC1032
SP1033	Motorola	MC1033
SP1034	Motorola	MC1034
SP1035	Motorola	MC1035
SP1039	Motorola	MC1039
SP1040	Motorola	MC1040
SP1047	Motorola	MC1047
SP1048	Motorola	MC1048
SP1201	Motorola	MC1201
SP1202	Motorola	MC1202
SP1203	Motorola	MC1203
SP1204	Motorola	MC1204
SP1205	Motorola	MC1205
SP1206	Motorola	MC1206
SP1207	Motorola	MC1207
SP1208	Motorola	MC1208
SP1209	Motorola	MC1209
SP1210	Motorola	MC1210
SP1211	Motorola	MC1211
SP1212	Motorola	MC1212
SP1213	Motorola	MC1213
SP1214	Motorola	MC1214
SP1215	Motorola	MC1215
SP1216	Motorola	MC1216
SP1220	Motorola	MC1220
SP1226	Motorola	MC1226
SP1230	Motorola	MC1226
SP1231	Motorola	MC1231

♦Discontinued

Bold face device numbers indicate manuracturers' data is provided in the IC Master on the pages noted.

Plessey Semiconductors (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
SP1233	Motorola	MC1233	
SP1235	Motorola	MC1235	
SP1239	Motorola	MC1239	
SP1240	Motorola	MC1240	
SP1247	Motorola	MC1247	
SP1248	Motorola	MC1248	
SP1660	Motorola	MC1660	
SP1662	Motorola	MC1662	
SP1664	Motorola	MC1664	
SP1666	Motorola	MC1666	
SP1668	Motorola	MC1668	
SP1670	Motorola	MC1670	
SP1690	Motorola	MC1690	
SP1692	Motorola	MC1692	
SP8616	Fairchild	11C05C	
SP8640	Fairchild	95H90	

Precision Monolithics, Inc.

Manufacturer Device	Replacement Source	Device	IC Master Page
DAC-08	AMD	DAC-08	
	Signetics	SE5008	
DAC-08C	Signetics	NE5007	
DAC-08E	Signetics	NE5008	
OP-07	Fairchild	μA714	
♦SSS108	RCA	CA108	
SSS1408	AMD	SSS1408	
	Motorola	MC1408	
SSS1508	AMD	SSS1508	
	Motorola	MC1508	
SSS208	Motorola	MLM208	
	RCA	CA208	
SSS308	Motorola	MLM308	
	RCA	CA308	
SSS747	AMD	SSS747	

Raytheon Semiconductor

Manufacturer Device	Replacement Source	Device	IC Master Page
AM2901	AMD	AM2901	
AM2905	AMD	AM2905	
AM2906	AMD	AM2906	
AM2907	AMD	AM2907	
AM2909	AMD	AM2909	
AM2918	AMD	AM2918	
LM101	AMD	LM101	
	Intersil	LM101	
	Motorola	MLM101	
	National	LM101	
	RCA	CA101	
	Signetics	LM101	
	Silicon G	SG101	
	Teledyne S	LM101	
	TI	LM101	
LM104	Motorola	MLM104	
	Silicon G	SG104	
	TI	LM104	
LM105	AMD	LM105	
	Intersil	LM105	
	Motorola	MLM105	
	National	LM105	
	Silicon G	SG105	
	Teledyne S	LM105	
	TI	LM105	
LM106	AMD	LM106	
	TI	LM106	
LM107	AMD	LM107	
	Intersil	LM107	
	Motorola	MLM107	
	National	LM107	
	RCA	CA107	
	Signetics	LM107	
	Silicon G	SG107	
	TI	LM107	
LM108	AMD	LM108	
	Intersil	LM108	
	Motorola	MLM108	
LM108	National	LM108	
	PMI	PM108	
	RCA	CA108	
	Signetics	LM108	
	Silicon G	SG108	
		SG108	
LM109	Motorola	MLM109	
	Silicon G	SG109	
	TI	LM109	
LM111	AMD	LM111	
	Intersil	LM111	
	Motorola	MLM111	
	National	LM111	
	RCA	CA111	
	Signetics	LM111	
	Silicon G	SG111	
	Teledyne S	LM111	
	TI	LM111	
LM112	AMD	LM112	
LM118	AMD	LM118	
	TI	LM118	
LM124	Motorola	MLM124	
	Silicon G	SG124	
	TI	LM124	
LM139	Motorola	MLM139	
	Silicon G	SG139	
	Teledyne S	LM139	
	TI	LM139	
LM201	AMD	LM201	
	Intersil	LM201	
	Motorola	MLM201	
	National	LM201	
	RCA	CA201	
	Silicon G	SG201	
	Teledyne S	LM201	
	TI	LM201	
LM204	Motorola	MLM204	
	Silicon G	SG204	
	Teledyne S	LM204	
	TI	LM204	
LM205	AMD	LM205	
	Intersil	LM205	
	Motorola	MLM205	
	National	LM205	
	Silicon G	SG205	
	Teledyne S	LM205	
	TI	LM205	
LM207	AMD	LM207	
	Intersil	LM207	
	Motorola	MLM207	
	National	LM207	
	RCA	CA207	
	Silicon G	SG207	
	TI	LM207	
LM208	AMD	LM208	
	Intersil	LM208	
	Motorola	MLM208	
	PMI	PM208	
	RCA	CA208	
	Silicon G	SG208	
LM211	AMD	LM211	
	Intersil	LM211	
	Motorola	MLM211	
	National	LM211	
	RCA	CA211	
	Signetics	LM211	
	Silicon G	SG211	
	Teledyne S	LM211	
	TI	LM211	
LM216	AMD	LM216	
LM224	Motorola	MLM224	
	Silicon G	SG224	
	TI	LM224	
LM239	Motorola	MLM239	
	Silicon G	SG239	
	Teledyne S	LM239	
	TI	LM239	
LM2900	National	LM2900	
LM2902	Motorola	MLM2902	
	National	LM2902	
	TI	LM2902	
LM301	AMD	LM301	
	Intersil	LM301	
	Motorola	MLM301	
	National	LM301	
	RCA	CA301	
	Signetics	LM301	
	Silicon G	SG301	
	Teledyne S	LM301	
	TI	LM301	
LM304	Motorola	MLM304	
	Silicon G	SG304	
	Teledyne S	LM304	
	TI	LM304	
LM305	AMD	LM305	
	Intersil	LM305	
	Motorola	MLM305	
	National	LM305	
	Silicon G	SG305	
	Teledyne S	LM305	
	TI	LM305	
LM306	AMD	LM306	
	TI	LM306	
LM307	AMD	LM307	
	Intersil	LM307	
	Motorola	MLM307	
	National	LM307	
	RCA	CA307	
	Signetics	LM307	
	Silicon G	SG307	
	TI	LM307	
LM308	AMD	LM308	
	Intersil	LM308	
	Motorola	MLM308	
	PMI	PM308	
	RCA	CA308	
	Signetics	LM308	
	Silicon G	SG308	
LM309	Motorola	MLM309	
	Silicon G	SG309	
	TI	LM309	
LM311	AMD	LM311	
	Intersil	LM311	
	Motorola	MLM311	
	National	LM311	
	RCA	CA311	
	Signetics	LM311	
	Silicon G	SG311	
	Teledyne S	LM311	
	TI	LM311	
LM312	AMD	LM312	
LM316	AMD	LM316	
LM318	AMD	LM318	
	TI	LM318	
LM324	Motorola	MLM324	
	Silicon G	SG324	
	TI	LM324	
LM339	Motorola	MLM339	
	RCA	CA339	
	Silicon G	SG339	
RC10144	Fairchild	F10410	
	Signetics	10144	
	TI	SN10144	
RC1414	Motorola	MC1414	
RC1437	Motorola	MC1437	
RC1458	**Harris**	**HA-2655**	**580**
	Motorola	MC1458	
	PMI	OP-14	
		SSS1458	
	RCA	CA1458	
	Signetics	MC1458	
	Silicon G	SG1458	
	Teledyne S	1458	
	TI	MC1458	
RC1488	Exar	XR1488	
	Motorola	MC1488	
	Silicon G	SG1488	
	TI	SN75188	
RC1489	Exar	XR1489	
	Motorola	MC1489	
	Silicon G	SG1489	
	TI	SN75189	
RC1556	Motorola	MC1456	
	Signetics	MC1456	
	Silicon G	SG1456	
RC2207	Exar	XR2207	
RC2211	Exar	XR2211	
RC2567	Exar	XR2567	
RC3403	Exar	XR3403	
	Fairchild	μA3403	
	Motorola	MC3403	
RC4136	Exar	XR4136	
		XR4212	
	Fairchild	μA4136	
	TI	RC4136	
RC4151	TI	XR4151	
RC4152	TI	XR4152	
RC4156	TI	XR4156	
RC4194	Exar	XR4194	
RC4531	Signetics	NE531	
RC4558	Exar	XR4558	
	Fairchild	μA4558	
	Motorola	MC4558	
	TI	RC4558	
RC5332	Fairchild	93411	
RC5342	Fairchild	93411	
RC5500	TI	SN74S314	
RC555	Exar	XR555	
	Fairchild	μA555	
	Intersil	NE555	
	Lithic Sys	LS555	
	Motorola	MC1455	
	RCA	CA555	
	Signetics	NE555	
	Silicon G	SG555	
	TI	NE555	
RC556	Exar	XR556	
	Fairchild	μA556	
	Motorola	MC3456	
	Signetics	NE556	
	Silicon G	SG556	
	Teledyne S	556	
	TI	NE556	
RC592	Motorola	NE592	
	Signetics	NE592	
RC702	Motorola	MC1712	
	TI	TL702	
RC709	Motorola	MC1709	
	Signetics	μA709	
	Teledyne S	709	
	TI	μA709	
RC710	Motorola	MC1710	
	Signetics	μA710	
	Silicon G	SG710	
	Teledyne S	710	
	TI	TL710	
RC711	Motorola	MC1711	
	Signetics	μA711	
	Silicon G	SG711	
	Teledyne S	711	
	TI	μA711	
RC723	AMD	723	
	Intersil	723	
	Motorola	MC1723	
	RCA	CA723	
	Signetics	μA723	
	Silicon G	SG723	
	Teledyne S	723	
	TI	μA723	
RC725	AMD	725	
	PMI	PM725	
		SSS725	
RC733	AMD	733	
	Fairchild	μA733	
	Motorola	MC1733	
	Signetics	μA733	
	Silicon G	SG733	
	TI	μA733	
RC741	AMD	741	
	Intersil	741	
	Motorola	MC1741	
	PMI	OP-02	
		SSS741	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Raytheon Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Replacement Device	IC Master Page
RC741	RCA	CA741	
	Signetics	μA741	
	Silicon G	SG741	
	Teledyne S	741	
	TI	μA741	
RC747	AMD	747	
	Motorola	MC1747	
	PMI	OP-04	
		SSS747	
	Signetics	μA747	
	Silicon G	SG747	
	Teledyne S	747	
	TI	μA747	
RC748	AMD	748	
	Intersil	748	
	Motorola	MC1748	
	RCA	CA748	
	Signetics	μA748	
	Silicon G	SG748	
	Teledyne S	748	
	TI	μA748	
RC7489	Intersil	IM5501	
RC75107	Fairchild	75107	
	Motorola	MC75107	
	TI	SN75107	
RC75108	Fairchild	75108	
	Motorola	MC75108	
	TI	SN75108	
RC75109	Fairchild	75109	
	TI	SN75109	
RC75110	Fairchild	75110	
	Motorola	MC75110	
	TI	SN75110	
♦RC7520	Signetics	7520	
	Silicon G	SG7520	
	TI	SN7520	
♦RC7521	Signetics	7521	
	Silicon G	SG7521	
	TI	SN7521	
RC7522	Motorola	MC7522	
	Signetics	7522	
	Silicon G	SG7522	
	TI	SN7522	
RC7523	Motorola	MC7523	
	Signetics	7523	
	Silicon G	SG7523	
	TI	SN7523	
RC75235	TI	SN75235	
RC7524	Fairchild	7524	
	Motorola	MC7524	
	Signetics	7524	
	Silicon G	SG7524	
	TI	SN7524	
RC7525	Fairchild	7525	
	Motorola	MC7525	
	Signetics	7525	
	Silicon G	SG7525	
	TI	SN7525	
RC7528	Fairchild	7528	
	Silicon G	SG7528	
	TI	SN7528	
RC7529	Fairchild	7529	
	Silicon G	SG7529	
	TI	SN7529	
RC75325	Fairchild	75325	
	Motorola	MC75325	
	Silicon G	SG75325	
RC8T09	Signetics	8T09	
RC8T10	Signetics	8T10	
RC8T13	Fairchild	8T13	
	Motorola	MC8T13	
	Signetics	8T13	
RC8T14	Fairchild	8T14	
	Motorola	MC8T14	
	Signetics	8T14	
RC8T23	Fairchild	8T23	
	Signetics	8T23	
RC8T24	Fairchild	8T24	
	Motorola	MC8T24	
	Signetics	8T24	
RC8200	Signetics	N8200	
RC8201	Signetics	N8201	
RC8202	Signetics	N8202	
RC8203	Signetics	N8203	
RC8225	Intersil	IM5501	
	Signetics	N8225	
	TI	SN74S189	
		SN74S289	
RC8230	Signetics	N8230	
RC8231	Signetics	N8231	
RC8233	Signetics	N8233	
RC8234	Signetics	N8234	
RC8241	Signetics	N8241	
RC8242	Signetics	N8242	
RC8243	Signetics	N8243	
RC8250	Signetics	N8250	
RC8251	Signetics	N8251	
RC8252	Signetics	N8252	
RC8260	Signetics	N8260	
RC8261	Signetics	N8261	
RC8263	Signetics	N8263	
RC8264	Signetics	N8264	
RC8266	Signetics	N8266	
RC8267	Signetics	N8267	
RC8270	Signetics	N8270	
	TI	SN74178	
RC8271	Signetics	N8271	
	TI	SN74179	
RC8273	Signetics	N8273	
RC8274	Signetics	N8274	
RC8280	Signetics	N8280	
	TI	SN74176	
RC8281	Signetics	N8281	
RC8290	Signetics	N8290	
		8290	
	TI	SN74196	
RC8291	Signetics	N8291	
	TI	SN74197	
RC930	Motorola	MC830	
	TI	SN15830	
RC932	Motorola	MC832	
	TI	SN15832	
RC933	Motorola	MC933	
	TI	SN15833	
RC934	Motorola	MC934	
	TI	SN15834	
RC935	Motorola	MC835	
	TI	SN15835	
RC936	Motorola	MC836	
RC937	Motorola	MC837	
	TI	SN15837	
RC940	Motorola	MC840	
RC941	Motorola	MC841	
RC944	Motorola	MC844	
	TI	SN15844	
RC945	Motorola	MC845	
	TI	SN15845	
RC946	Motorola	MC846	
	TI	SN15846	
RC948	Motorola	MC848	
	TI	SN15848	
RC949	Motorola	MC849	
	TI	SN15849	
RC950	Motorola	MC850	
	TI	SN15850	
RC951	Motorola	MC851	
	TI	SN15851	
RC957	Motorola	MC857	
	TI	SN15857	
RC958	Motorola	MC858	
	TI	SN15858	
RC961	Motorola	MC861	
	TI	SN15861	
RC962	Motorola	MC862	
	TI	SN15862	
RC9621	Fairchild	9621	
RC9622	Fairchild	9622	
RC963	Motorola	MC863	
RC963	TI	SN15863	
RC993	Motorola	MC853	
	TI	SN158093	
RC994	Motorola	MC856	
	TI	SN158094	
RC997	Motorola	MC855	
	TI	SN158097	
RC999	Motorola	MC852	
	TI	SN158092	
RM1514	Motorola	MC1514	
	TI	TL514	
RM1537	Motorola	MC1537	
RM1556	Motorola	MC1556	
	Signetics	MC1556	
	Silicon G	SG1556	
RM1558	**Harris**	**HA-2650**	**581**
	Motorola	MC1558	
	PMI	PM1558	
		SSS1558	
	RCA	CA1558	
	Signetics	MC1558	
	Silicon G	SG1558	
	Teledyne S	1558	
	TI	MC1558	
RM2207	Exar	XR2207	
RM2211	Exar	XR2211	
RM2567	Exar	XR2567	
RM3503	Exar	XR3503	
	Fairchild	μA3503	
	Motorola	MC3503	
RM4136	Exar	XR4136	
	Fairchild	μA4136	
	TI	RM4136	
RM4151	TI	XR4151	
RM4152	TI	XR4152	
RM4156	TI	XR4156	
RM4194	Exar	XR4194	
RM4531	Signetics	SE531	
RM4558	Motorola	MC4558	
	RCA	CA1558	
	Silicon G	SG1558	
	TI	RM4558	
RM55107	Fairchild	55107	
	Motorola	MC55107	
	TI	SN55107	
RM55108	Fairchild	55108	
	TI	SN55108	
RM55109	Fairchild	55109	
	TI	SN55109	
RM55110	Fairchild	55110	
	TI	SN55110	
RM5524	Fairchild	5524	
	TI	SN5524	
RM5525	Fairchild	5525	
	TI	SN5525	
RM55325	Fairchild	55325	
	Motorola	MC55325	
	TI	SN55325	
RM555	AMD	SE555	
	Fairchild	μA555	
	Intersil	SE555	
	Lithic Sys	LS555	
	Motorola	MC1555	
	Signetics	SE555	
	Silicon G	SG555	
	TI	SE555	
RM556	Fairchild	μA556	
	Motorola	MC3556	
	Silicon G	SG556	
	TI	SE556	
RM592	Motorola	SE592	
	Signetics	SE592	
RM702	Motorola	MC1712	
	TI	μA702	
RM709	Motorola	MC1709	
	Signetics	μA709	
	Teledyne S	709	
	TI	μA709	
RM710	Motorola	MC1710	
	Signetics	μA710	
	Silicon G	SG710	
RM710	Teledyne S	710	
	TI	μA710	
RM711	Motorola	MC1711	
	Signetics	μA711	
	Silicon G	SG711	
	Teledyne S	711	
	TI	μA711	
RM723	AMD	723	
	Intersil	723	
	Motorola	MC1723	
	RCA	CA723	
	Signetics	μA723	
	Silicon G	SG723	
	Teledyne S	723	
	TI	μA723	
RM725	AMD	725	
	PMI	PM725	
		SSS725	
RM733	AMD	733	
	Fairchild	μA733	
	Motorola	MC1733	
	Signetics	μA733	
	Silicon G	SG733	
	TI	μA733	
RM741	AMD	741	
	Intersil	741	
	Motorola	MC1741	
	PMI	OP-02	
		SSS741	
	RCA	CA741	
	Signetics	μA741	
	Silicon G	SG741	
	Teledyne S	741	
	TI	μA741	
RM747	AMD	747	
	Motorola	MC1747	
	PMI	PM747	
		SSS747	
	Signetics	μA747	
	Silicon G	SG747	
	Teledyne S	747	
	TI	μA747	
RM748	AMD	748	
	Intersil	748	
	Motorola	MC1748	
	RCA	CA748	
	Signetics	μA748	
	Silicon G	SG748	
	Teledyne S	748	
	TI	SN52748	
RM8T13	Fairchild	8T13	
RM8T14	Fairchild	8T14	
RM930	Motorola	MC930	
	TI	SN15930	
RM932	Motorola	MC932	
	TI	SN15932	
RM933	Motorola	MC933	
	TI	SN15933	
RM934	Motorola	MC934	
	TI	SN15934	
RM935	Motorola	MC935	
	TI	SN15935	
RM936	Motorola	MC936	
	TI	SN15936	
RM937	Motorola	MC937	
	TI	SN15937	
RM940	Motorola	MC940	
RM941	Motorola	MC941	
RM944	Motorola	MC944	
	TI	SN15944	
RM945	Motorola	MC945	
	TI	SN15945	
RM946	Motorola	MC946	
	TI	SN15946	
RM947	TI	SN15947	
RM948	Motorola	MC948	
	TI	SN15948	
RM949	Motorola	MC949	
	TI	SN15949	
RM950	Motorola	MC950	
	TI	SN15950	

♦ Discontinued

Bold face device numbers indicate manufacturers' data is provided in the IC Master on the pages noted.

Raytheon Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
RM951	Motorola	MC951	
	TI	SN15951	
RM957	Motorola	MC957	
	TI	SN15957	
RM958	Motorola	MC958	
	TI	SN15958	
RM961	Motorola	MC961	
	TI	SN15961	
RM962	Motorola	MC962	
	TI	SN15962	
RM9621	Fairchild	9621	
RM9622	Fairchild	9622	
RM963	Motorola	MC963	
	TI	SN15963	
RM993	Motorola	MC953	
	TI	SN159093	
RM994	Motorola	MC956	
	TI	SN159094	
RM997	Motorola	MC955	
	TI	SN159097	
RM999	Motorola	MC952	
	TI	SN159099	
RV4151	TI	XR4151	
RV4152	TI	XR4152	
RV4156	TI	XR4156	
SP3724	RCA	CA3724	
SP3725	RCA	CA3725	
54LS00	Signetics	54LS00	
54LS01	Signetics	54LS01	
54LS02	Signetics	54LS02	
54LS03	Signetics	54LS03	
54LS04	Signetics	54LS04	
54LS05	Signetics	54LS05	
54LS08	Signetics	54LS08	
54LS09	Signetics	54LS09	
54LS10	Signetics	54LS10	
54LS109	Signetics	54LS109	
54LS11	Signetics	54LS11	
54LS112	Signetics	54LS112	
54LS113	Signetics	54LS113	
54LS114	Signetics	54LS114	
54LS12	Signetics	54LS12	
54LS136	Signetics	54LS136	
54LS138	Signetics	54LS138	
54LS139	Signetics	54LS139	
54LS15	Signetics	54LS15	
54LS151	Signetics	54LS153	
54LS157	Signetics	54LS157	
54LS158	Signetics	54LS158	
54LS160	Signetics	54LS160	
54LS161	Signetics	54LS161	
54LS162	Signetics	54LS162	
54LS163	Signetics	54LS163	
54LS174	Signetics	54LS174	
54LS175	Signetics	54LS175	
54LS181	Signetics	54LS181	
54LS190	Signetics	54LS190	
54LS191	Signetics	54LS191	
54LS192	Signetics	54LS192	
54LS193	Signetics	54LS193	
54LS194A	Signetics	54LS194A	
54LS195A	Signetics	54LS195A	
54LS196	Signetics	54LS196	
54LS197	Signetics	54LS197	
54LS20	Signetics	54LS20	
54LS21	Signetics	54LS21	
54LS22	Signetics	54LS22	
54LS251	Signetics	54LS251	
54LS253	Signetics	54LS253	
54LS257	Signetics	54LS257	
54LS258	Signetics	54LS258	
54LS26	Signetics	54LS26	
54LS27	Signetics	54LS27	
54LS28	Signetics	54LS28	
54LS283	Signetics	54LS283	
54LS295A	Signetics	54LS295A	
54LS30	Signetics	54LS30	
54LS32	Signetics	54LS32	
54LS33	Signetics	54LS33	
54LS37	Signetics	54LS37	
54LS38	Signetics	54LS38	
54LS386	Signetics	54LS386	
54LS40	Signetics	54LS40	
54LS51	Signetics	54LS51	
54LS54	Signetics	54LS54	
54LS55	Signetics	54LS55	
54LS670	Signetics	54LS670	
54LS73	Signetics	54LS73	
54LS74	Signetics	54LS74	
54LS76	Signetics	54LS76	
54LS78	Signetics	54LS78	
54LS83A	Signetics	54LS83A	
54LS86	Signetics	54LS86	
54LS95B	Signetics	54LS95B	
54170	Fairchild	54170	
	TI	SN54170	

RCA Solid State Division

Manufacturer Device	Replacement Source	Device	IC Master Page
CA101	**AD**	**AD101**	**575**
	AMD	LM101	
	Fairchild	μA101	
	Intersil	LM101	
	Motorola	MLM101	
	National	LM101	
	NPC	SFC2121	
	Signetics	LM101	
	Silicon G	SG101	
	Teledyne S	LM101	
	TI	LM101	
CA107	AMD	LM107	
	Intersil	LM107	
	Motorola	MLM107	
	National	LM107	
	Raytheon	LM107	
	Signetics	LM107	
	Silicon G	SG107	
	TI	LM107	
CA108	AMD	LM108	
	Fairchild	μA108	
	Motorola	MLM108	
	National	LM108	
	PMI	PM108	
	Raytheon	LM108	
	Signetics	LM108	
	Silicon G	SG108	
CA111	AMD	LM111	
	Intersil	LM111	
	Motorola	MLM111	
	National	LM111	
	NPC	SFC2111	
	Raytheon	LM111	
	Signetics	LM111	
	Silicon G	SG111	
	Teledyne S	LM111	
	TI	LM111	
CA1310	Motorola	MC1310	
	Sprague	ULN-2210	
CA1391	Sprague	ULN-2291	
CA1398	Motorola	MC1398	
	Sprague	ULN-2298	
CA1458	Fairchild	μA1458	
	Harris	**HA-2655**	**580**
	Motorola	MC1458	
	National	LM1458	
	PMI	OP-14	
		SSS1458	
	Raytheon	RC1458	
	Signetics	MC1458	
	Silicon G	SG1458	
	Teledyne S	1458	
	TI	MC1458	
CA1541	Motorola	MC1441	
CA1558	Fairchild	μA1558	
	Harris	**HA-2650**	**581**
	Motorola	MC1558	
	National	LM1558	
CA1558	PMI	PM1558	
		SSS1558	
	Raytheon	RM1558	
	Signetics	MC1558	
	Silicon G	SG1558	
	Teledyne S	1558	
	TI	MC1558	
CA201	**AD**	**AD201**	**575**
	AMD	LM201	
	Fairchild	μA201	
	Intersil	LM201	
	Motorola	MLM201	
	National	LM201	
	Signetics	LM201	
	Silicon G	SG201	
	Siliconix	LM201	
	Teledyne S	LM201	
	TI	LM201	
CA207	AMD	LM207	
	Fairchild	μA207	
	Intersil	LM207	
	Motorola	MLM207	
	National	LM207	
	Raytheon	LM207	
	Signetics	LM207	
	Silicon G	SG207	
	TI	LM207	
CA208	**AD**	**AD208**	**575**
	AMD	LM208	
	Fairchild	μA208	
	Intersil	LM208	
	Motorola	MLM208	
	National	LM208	
	NPC	SFC2208	
	PMI	PM208	
	Raytheon	LM208	
	Signetics	LM208	
	Silicon G	SG208	
CA211	AMD	LM211	
	Intersil	LM211	
	Motorola	MLM211	
	National	LM211	
	NPC	SFC2211	
	Raytheon	LM211	
	Signetics	LM211	
	Silicon G	SG211	
	Teledyne S	LM211	
	TI	LM211	
CA2111	Motorola	MC1357	
	Sprague	ULN-2111	
CA239	Motorola	MLM239	
	Silicon G	SG239	
	Teledyne S	LM239	
	TI	LM239	
CA301	**AD**	**AD301**	**575**
	Fairchild	μA301	
	Intersil	LM301	
	Motorola	MLM301	
	National	LM301	
	NPC	SFC2301	
	Raytheon	LM301	
	Signetics	LM301	
	Silicon G	SG301	
	Teledyne S	LM301	
	TI	LM301	
CA3011	Motorola	MC1590	
CA3012	Motorola	MC1590	
CA3013	Motorola	MC1355	
CA3014	Motorola	MC1357	
CA3018	Fairchild	μA3018	
	Lithic Sys	LA3018	
	NPC	SFC2018	
	Silicon G	SG3818	
CA3019	Fairchild	μA3019	
CA3026	Fairchild	μA3026	
	Lithic Sys	LA3026	
	Silicon G	SG3822	
CA3028	Lithic Sys	LS3028	
♦CA3031	Motorola	MC1712	
♦CA3032	Motorola	MC1712	
CA3036	Fairchild	μA3036	
CA3036	NPC	SFC2036	
CA3038	Motorola	MC1709	
CA3039	Fairchild	μA3039	
CA3044	Fairchild	μA3064	
CA3045	Fairchild	μA3045	
	Lithic Sys	LA3045	
	National	LM3045	
	Plessey	SL3045	
	Silicon G	SG3045	
		SG3821	
	Sprague	ULS-2045	
CA3046	Fairchild	μA3046	
	Lithic Sys	LA3046	
	Motorola	MC3346	
	National	LM3046	
	NPC	SFC2046	
	Plessey	SL3046	
	Silicon G	SG3046	
		SG3821	
	Sprague	ULN-2046	
CA3049	Lithic Sys	LA3049	
	Silicon G	SG3822	
CA3053	Lithic Sys	LS3053	
CA3054	Fairchild	μA3054	
	Motorola	CA3054	
	National	LM3054	
	NPC	SFC2054	
	Silicon G	SG3822	
	Sprague	ULN-2054	
CA3055	Silicon G	SG300	
CA3056	Motorola	MC1741	
CA3058	Plessey	SL447	
	Silicon G	SG3058	
CA3059	Motorola	CA3059	
	Plessey	SL448	
	Silicon G	SG3059	
CA3064	Fairchild	μA3064	
	Motorola	MC1364	
	Sprague	ULN-2264	
CA3065	Fairchild	μA3065	
	Motorola	MC1358	
	Sprague	ULN-2165	
CA3066	Fairchild	μA3066	
CA3067	Fairchild	μA3067	
CA307	AMD	LM307	
	Fairchild	μA307	
	Intersil	LM307	
	Motorola	MLM307	
	National	LM307	
	Raytheon	LM307	
	Signetics	LM307	
	Silicon G	SG307	
	TI	LM307	
CA3070	Fairchild	μA780	
	Sprague	ULN-2124	
CA3071	Fairchild	μA781	
	Sprague	ULN-2127	
CA3072	Fairchild	μA746	
	Sprague	ULN-2114	
CA3075	Fairchild	μA3075	
	Motorola	MC1375	
	Sprague	ULN-2129	
CA3076	Fairchild	μA3076	
CA3079	Plessey	SL449	
	Silicon G	SG3079	
CA308	**AD**	**AD308**	**575**
	AMD	LM308	
	Fairchild	μA308	
	Intersil	LM308	
	Motorola	MLM308	
	National	LM308	
	NPC	SFC308	
	PMI	PM308	
	Raytheon	LM308	
	Signetics	LM308	
	Silicon G	SG308	
CA3081	Silicon G	SG3081	
	Sprague	ULN-2081	
CA3082	Silicon G	SG3082	
	Sprague	ULN-2082	
CA3083	Silicon G	SG3083	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

RCA Solid State Division (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
CA3086	Fairchild	μA3086	
	Lithic Sys	LA3086	
	Motorola	MC3386	
	National	LM3086	
	Plessey	SL3086	
	Silicon G	SG3086	
CA3089	Fairchild	μA3089	
	SGS	TDA1200	
	Sprague	ULN-2289	
CA311	AMD	LM311	
	Fairchild	μA311	
	Intersil	LM311	
	Motorola	MLM311	
	National	LM311	
	NPC	SFC3111	
	Raytheon	LM311	
	Signetics	LM311	
	Silicon G	SG311	
	Teledyne S	LM311	
	TI	LM311	
CA3120	Sprague	ULN-2125	
CA3121	Sprague	ULN-2269	
CA3123	Sprague	ULN-2137	
CA3126	Fairchild	μA787	
	Sprague	ULN-2262	
CA3146	Silicon G	SG3146	
CA3183	Silicon G	SG3183	
CA324	Motorola	MLM324	
	National	LM324	
	Signetics	LM324	
	Silicon G	SG324	
	TI	LM324	
CA3302	Motorola	MC3302	
	Silicon G	SG3302	
CA339	Motorola	MLM339	
	National	LM339	
	Raytheon	LM339	
	Signetics	LM339	
	Silicon G	SG339	
	Teledyne S	LM339	
	TI	LM339	
CA3401	Motorola	MC3401	
♦CA3458	RCA	CA1458	
♦CA3558	RCA	CA1558	
♦CA3741	RCA	CA741	
♦CA3747	RCA	CA747	
♦CA3748	RCA	CA748	
CA555	AMD	NE555	
		SE555	
	Exar	XR555	
	Intersil	NE555	
	Lithic Sys	LS555	
	Motorola	MC1455	
		MC1555	
	National	LM555	
	Raytheon	RC555	
		RM555	
	Signetics	NE555	
	Silicon G	SG555	
	TI	NE555	
		SE555	
CA723	AMD	723	
	Fairchild	μA723	
	Intersil	723	
	Motorola	MC1723	
	National	LM723	
	NPC	SFC2723	
	Raytheon	RC723	
	Signetics	μA723	
	Silicon G	SG723	
	Teledyne S	723	
	TI	μA723	
CA741	**AD**	**AD741**	**575**
	AMD	SSS741	
		741	
	Fairchild	μA741	
	Intersil	SSS741	
CA741	Intersil	741	
	Motorola	MC1741	
	National	LM741	
	NPC	SFC2741	
	PMI	OP-02	
		PM741	
		SSS741	
	Raytheon	RC741	
		RM741	
	Signetics	μA741	
	Silicon G	SG741	
	Teledyne S	741	
	TI	μA741	
CA747	AMD	SSS747	
		747	
	Fairchild	μA747	
	Intersil	SSS747	
	Motorola	MC1747	
	National	LM747	
	PMI	OP-04	
		PM747	
		SSS747	
	Raytheon	RC747	
		RM747	
	Signetics	μA747	
	Silicon G	SG747	
	Teledyne S	747	
	TI	μA747	
CA748	AMD	748	
	Fairchild	μA748	
	Intersil	748	
	Motorola	MC1748	
	National	LM748	
	Raytheon	RC748	
		RM748	
	Signetics	μA748	
	Silicon G	SG748	
		SG748	
	Teledyne S	748	
	TI	μA748	
		μA748	
CA758	Sprague	ULN-2244	
CA810	Motorola	MC1384	
	SGS	TBA810	
CDP1802	Hughes	HMPC1802	
CD4000	Harris	HD4000	
	Mitel	SIL4000	
	Motorola	MC14000	
	Solitron	CM4000	
	SSS	SCL4000	
	TI	TP4000	
CD4001	Fairchild	F4001	
	GI	MEM4001	
	Harris	HD4001	
	Mitel	SIL4001	
		SIL4901	
	Motorola	MC14001	
	National	CD4001	
	SGS	HBF4001	
	Solitron	CM4001	
	SSS	SCL4001	
	SW	SW4001	
	TI	TP4001	
	Toshiba	TC4001	
CD4002	Fairchild	F4002	
	Harris	HD4002	
	Motorola	MC14002	
	National	CD4002	
	SGS	HBF4002	
	Solitron	CM4002	
	SSS	SCL4002	
	SW	SW4002	
	TI	TP4002	
	Toshiba	TC4002	
CD4006	Fairchild	F4006	
	Harris	HD4006	
	Motorola	MC14006	
	National	CD4006	
	Solitron	CM4006	
	SSS	SCL4006	
CD4007	Fairchild	F4007	
CD4007	GI	MEM4007	
	Harris	HD4007	
	Mitel	SIL4007	
	Motorola	MC14007	
	National	CD4007	
	SGS	HBF4007	
	Solitron	CM4007	
	SSS	SCL4007	
	TI	TP4007	
	Toshiba	TC4007	
CD4008	Fairchild	F4008	
	Harris	HD4008	
	Motorola	MC14008	
	National	CD4008	
	SGS	HBF4008	
	Solitron	CM4008	
	SSS	SCL4008	
	TI	TP4008	
	Toshiba	TC4008	
CD4009	National	CD4009	
	SGS	HBF4009	
	Solitron	CM4009	
	SSS	SCL4009	
	TI	TP4009	
	Toshiba	TC4009	
CD4010	Mitel	SIL4010	
	National	CD4010	
	SGS	HBF4010	
	Solitron	CM4010	
	SSS	SCL4010	
	TI	TP4010	
	Toshiba	TC4010	
CD40106	Motorola	MC14584	
	National	CD40106	
		MM74C14	
CD4011	Fairchild	F4011	
	GI	MEM4011	
	Harris	HD4011	
	Mitel	SIL4011	
		SIL4911	
	Motorola	MC14011	
	National	CD4011	
	SGS	HBF4011	
	Solitron	CM4011	
	SSS	SCL4011	
	SW	SW4011	
	TI	TP4011	
	Toshiba	TC4011	
CD4012	Harris	HD4012	
	Mitel	SIL4012	
		SIL4912	
	Motorola	MC14012	
	National	CD4012	
	SGS	HBF4012	
	Solitron	CM4012	
	SSS	SCL4012	
	SW	SW4012	
	TI	TP4012	
	Toshiba	TC4012	
CD4013	Fairchild	F4013	
	GI	MEM4013	
	Harris	HD4013	
	Mitel	SIL4013	
	Motorola	MC14013	
	SGS	HBF4013	
	Solitron	CM4013	
	SSS	SCL4013	
	SW	SW4013	
	TI	TP4013	
	Toshiba	TC4013	
CD4014	Fairchild	F4014	
	Harris	HD4014	
	Mitel	SIL4014	
	Motorola	MC14014	
	National	CD4014	
	SGS	HBF4014	
	Solitron	CM4014	
	SSS	SCL4014	
	TI	TP4014	
	Toshiba	TC4014	
CD4015	Fairchild	F4015	
CD4015	Harris	HD4015	
	Mitel	SIL4015	
	Motorola	MC14015	
	National	CD4015	
	SGS	HBF4015	
	Solitron	CM4015	
	SSS	SCL4015	
	SW	SW4015	
	TI	TP4015	
CD4016	**AD**	**AD7516**	**430**
	Fairchild	F4016	
	Mitel	SIL4016	
	Motorola	MC14016	
	National	CD4016	
	Solitron	CM4016	
	SSS	SCL4016	
	TI	TP4016	
CD4017	Fairchild	F4017	
	Harris	HD4017	
	Mitel	SIL4017	
	Motorola	MC14017	
	National	CD4017	
	SGS	HBF4017	
	Solitron	CM4017	
	SSS	SCL4017	
	SW	SW4017	
	TI	TP4017	
	Toshiba	TC4017	
CD4018	Fairchild	F4018	
	Harris	HD4018	
	Mitel	SIL4018	
	National	CD4018	
	SGS	HBF4018	
	Solitron	CM4018	
	SSS	SCL4018	
	TI	TP4018	
	Toshiba	TC4018	
CD4019	Fairchild	F4019	
	Harris	HD4019	
	Mitel	SIL4019	
	Motorola	MC14519	
	National	CD4019	
	SGS	HBF4019	
	Solitron	CM4019	
	SSS	SCL4019	
	SW	SW4019	
	TI	TP4019	
	Toshiba	TC4019	
CD40192	Fairchild	F40192	
	National	CD40192	
		MM74C192	
CD40193	Fairchild	F40193	
	National	CD40193	
		MM74C193	
CD40194	Fairchild	F40194	
CD40196	Fairchild	F40196	
CD4020	Fairchild	F4020	
	Harris	HD4020	
	Mitel	SIL4020	
	Motorola	MC14020	
	National	CD4020	
	SGS	HBF4020	
	Solitron	CM4020	
	SSS	SCL4020	
	SW	SW4020	
	TI	TP4020	
	Toshiba	TC4020	
CD4021	Fairchild	F4021	
	Harris	HD4021	
	Mitel	SIL4021	
	Motorola	MC14021	
	National	CD4021	
	Solitron	CM4021	
	SSS	SCL4021	
	SW	SW4021	
	TI	TP4021	
	Toshiba	TC4021	
CD4022	Fairchild	F4022	
	Harris	HD4022	
	Mitel	SIL4022	
	Motorola	MC14022	

♦ Discontinued

Bold face device numbers indicate manufacturers' data is provided in the IC Master on the pages noted.

RCA Solid State Division (cont'd)

Manufacturer Device	Replacement Source	Replacement Device	IC Master Page
CD4022	National	CD4022	
	SGS	HBF4022	
	Solitron	CM4022	
	SSS	SCL4022	
	TI	TP4022	
	Toshiba	TC4022	
CD4023	Fairchild	F4023	
	Harris	HD4023	
	Mitel	SIL4023	
		SIL4923	
	Motorola	MC14023	
	National	CD4023	
	SGS	HBF4023	
	Solitron	CM4023	
	SSS	SCL4023	
	SW	SW4023	
	TI	TP4023	
	Toshiba	TC4023	
CD4024	Fairchild	F4024	
	Harris	HD4024	
	Mitel	SIL4024	
	Motorola	MC14024	
	National	CD4024	
	SGS	HBF4024	
	Solitron	CM4024	
	SSS	SCL4024	
	SW	SW4024	
	TI	TP4024	
	Toshiba	TC4024	
CD4025	Fairchild	F4025	
	Harris	HD4025	
	Mitel	SIL4025	
		SIL4925	
	Motorola	MC14025	
	National	CD4025	
	SGS	HBF4025	
	Solitron	CM4025	
	SSS	SCL4025	
	SW	SW4025	
	TI	TP4025	
	Toshiba	TC4025	
CD4026	Solitron	CM4026	
	SSS	SCL4026	
CD4027	Fairchild	F4027	
	Harris	HD4027	
	Mitel	SIL4027	
	Motorola	MC14027	
	National	CD4027	
	SGS	HBF4027	
	Solitron	CM4027	
	SSS	SCL4027	
	SW	SW4027	
	TI	TP4027	
	Toshiba	TC4027	
CD4028	Fairchild	F4028	
	Harris	HD4028	
	Mitel	SIL4028	
	Motorola	MC14028	
	National	CD4028	
	SGS	HBF4028	
	Solitron	CM4028	
	SSS	SCL4028	
	SW	SW4028	
	TI	TP4028	
	Toshiba	TC4028	
CD4029	Fairchild	F4029	
	Harris	HD4029	
	Mitel	SIL4029	
	National	CD4029	
	SGS	HBF4029	
	Solitron	CM4029	
	SSS	SCL4029	
	SW	SW4029	
	TI	TP4029	
	Toshiba	TC4029	
CD4030	Fairchild	F4030	
	Harris	HD4030	
CD4030	Mitel	SIL4030	
	National	CD4030	
	SGS	HBF4030	
	Solitron	CM4030	
	SSS	SCL4030	
	SW	SW4030	
	TI	TP4030	
	Toshiba	TC4030	
CD4031	Fairchild	F4031	
	National	CD4031	
CD4032	Motorola	MC14032	
	Solitron	CM4032	
	Toshiba	TC4032	
CD4033	SGS	HBF4033	
	Solitron	CM4033	
	SSS	SCL4033	
CD4034	Fairchild	F4034	
	Motorola	MC14034	
	Solitron	CM4034	
	SSS	SCL4034	
	Toshiba	TC4034	
CD4035	Fairchild	F4035	
	Harris	HD4035	
	Mitel	SIL4035	
	Motorola	MC14035	
	National	CD4035	
	SGS	HBF4035	
	Solitron	CM4035	
	SSS	SCL4035	
	TI	TP4035	
	Toshiba	TC4035	
CD4036	Solitron	CM4036	
CD4037	Solitron	CM4037	
CD4038	Motorola	MC14038	
	Solitron	CM4038	
	Toshiba	TC4038	
CD4039	Solitron	CM4039	
CD4040	Fairchild	F4040	
	Harris	HD4040	
	Mitel	SIL4040	
	Motorola	MC14040	
	National	CD4040	
	Solitron	CM4040	
	SSS	SCL4040	
	TI	TP4040	
	Toshiba	TC4040	
CD4041	Fairchild	F4041	
	Solitron	CM4041	
	SSS	SCL4041	
CD4042	Fairchild	F4042	
	Harris	HD4042	
	Mitel	SIL4042	
	Motorola	MC14042	
	National	CD4042	
	SGS	HBF4042	
	Solitron	CM4042	
	SSS	SCL4042	
	TI	TP4042	
	Toshiba	TC4042	
CD4043	Fairchild	F4043	
	Harris	HD4043	
	Mitel	SIL4043	
	Motorola	MC14043	
	National	CD4043	
	Solitron	CM4043	
	SSS	SCL4043	
	TI	TP4043	
	Toshiba	TC4043	
CD4044	Fairchild	F4044	
	Harris	HD4044	
	Mitel	SIL4044	
	Motorola	MC14044	
	National	CD4044	
	Solitron	CM4044	
	SSS	SCL4044	
	TI	TP4044	
	Toshiba	TC4044	
CD4045	SGS	HBF4045	
	Solitron	CM4045	
	SSS	SCL4445	
CD4046	Fairchild	F4046	
CD4046	Mitel	SIL4046	
	Motorola	MC14046	
	Solitron	CM4046	
	SSS	SCL4046	
CD4047	Fairchild	F4047	
	Solitron	CM4047	
	TI	TP4047	
	Toshiba	TC4047	
CD4048	National	CD4048	
	Solitron	CM4048	
CD4049	Fairchild	F4049	
	GI	MEM4049	
	Harris	HD4049	
	Mitel	SIL4049	
	Motorola	MC14049	
	National	CD4049	
	SGS	HBF4049	
	Solitron	CM4049	
	SSS	SCL4049	
	SW	SW4049	
	TI	TP4049	
	Toshiba	TC4049	
CD4050	Fairchild	F4050	
	GI	MEM4050	
	Harris	HD4050	
	Mitel	SIL4050	
	Motorola	MC14050	
	National	CD4050	
	SGS	HBF4050	
	Solitron	CM4050	
	SSS	SCL4050	
	SW	SW4050	
	TI	TP4050	
	Toshiba	TC4050	
CD4051	Fairchild	F4051	
	Harris	HD4051	
	Mitel	SIL4051	
	National	CD4051	
	Solitron	CM4051	
	SSS	SCL4051	
	TI	TP4051	
CD4052	Fairchild	F4052	
	Harris	HD4052	
	Mitel	SIL4052	
	National	CD4052	
	Solitron	CM4052	
	SSS	SCL4052	
	TI	TP4052	
CD4053	Fairchild	F4053	
	GI	MEM4053	
	Mitel	SIL4053	
	National	CD4053	
	Solitron	CM4053	
	SSS	SCL4053	
	TI	TP4053	
CD4055	Mitel	SIL4055	
CD4056	Mitel	SIL4056	
CD4060	Mitel	SIL4060	
	SSS	SCL4060	
CD4061	Toshiba	TC4061	
CD4066	Fairchild	F4066	
	Harris	HD4066	
	Mitel	SIL4066	
	National	CD4066	
	SGS	HBF4066	
	Solitron	CM4066	
		CM4116	
	SSS	SCL4066	
CD4067	Fairchild	F4067	
CD4068	Fairchild	F4068	
	Mitel	SIL4068	
		SIL4968	
	Motorola	MC14068	
	SSS	SCL4068	
	TI	TP4068	
	Toshiba	TC4068	
CD4069	Fairchild	F4069	
	Harris	HD4069	
		HD54C04	
		HD74C04	
	Mitel	SIL4069	
CD4069	Motorola	MC14069	
	National	CD4069	
		MM54C04	
		MM74C04	
	SSS	SCL4069	
	TI	TP4069	
	Toshiba	TC4069	
CD4070	Fairchild	F4070	
	Harris	HD4070	
	Mitel	SIL4070	
	National	CD4070	
		MM74C86	
	Solitron	CM4030	
	SSS	SCL4070	
CD4071	Fairchild	F4071	
	Mitel	SIL4071	
	Motorola	MC14071	
	SSS	SCL4071	
	TI	TP4071	
	Toshiba	TC4071	
CD4072	Fairchild	F4072	
	Mitel	SIL4072	
	Motorola	MC14072	
	SSS	SCL4072	
	TI	TP4072	
	Toshiba	TC4072	
CD4073	Fairchild	F4073	
	Mitel	SIL4073	
	Motorola	MC14073	
	SSS	SCL4073	
	TI	TP4073	
	Toshiba	TC4073	
CD4075	Fairchild	F4075	
	Mitel	SIL4075	
	Motorola	MC14075	
	SSS	SCL4075	
	TI	TP4075	
	Toshiba	TC4075	
CD4076	Fairchild	F4076	
	Harris	HD4076	
		HD54C173	
		HD74C173	
	Mitel	SIL4076	
	Motorola	MC14076	
	National	CD4076	
		MM54C173	
		MM74C173	
	SSS	SCL4076	
CD4077	Fairchild	F4077	
	Mitel	SIL4077	
	Solitron	CM4077	
	SSS	SCL4077	
CD4078	Fairchild	F4078	
	Mitel	SIL4078	
		SIL4978	
	Motorola	MC14078	
	SSS	SCL4078	
	TI	TP4078	
	Toshiba	TC4078	
CD4081	Fairchild	F4081	
	Harris	HD4081	
	Mitel	SIL4081	
	Motorola	MC14081	
	SSS	SCL4081	
	TI	TP4081	
	Toshiba	TC4081	
CD4082	Fairchild	F4082	
	Mitel	SIL4082	
	Motorola	MC14082	
	SSS	SCL4082	
	TI	TP4082	
	Toshiba	TC4082	
CD4085	Fairchild	F4085	
CD4086	Fairchild	F4086	
CD4093	SSS	SCL4093	
CD4094	SSS	SCL4094	
CD4098	Mitel	SIL4098	
CD4099	Fairchild	F4099	
CD4502	Mitel	SIL4502	
CD4508	Mitel	SIL4508	
	Motorola	MC14508	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

RCA Solid State Division (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
CD4508	Solitron	CM4508	
	SSS	SCL4508	
	Toshiba	TC4508	
CD4510	Mitel	SIL4510	
	National	CD4510	
	SSS	SCL4510	
CD4511	Fairchild	F4511	
	Mitel	SIL4511	
	Motorola	MC14511	
	National	CD4511	
	Solitron	CM4511	
	SSS	SCL4511	
	TI	TP4511	
CD4514	Fairchild	F4514	
	Mitel	SIL4514	
	Motorola	MC14514	
	Solitron	CM4514	
	SSS	SCL4514	
	Toshiba	TC4514	
CD4515	Fairchild	F4515	
	Mitel	SIL4515	
	Motorola	MC14515	
	Solitron	CM4515	
	SSS	SCL4515	
	Toshiba	TC4515	
CD4516	Fairchild	F4516	
	Harris	HD14516	
	Mitel	SIL4516	
	Motorola	MC14516	
	National	CD4516	
	SSS	SCL4516	
CD4518	Fairchild	F4518	
	Harris	HD14518	
	Mitel	SIL4518	
	Motorola	MC14518	
	National	CD4518	
	SSS	SCL4518	
	TI	TP4518	
	Toshiba	TC4518	
CD4520	Fairchild	F4520	
	Harris	HD14520	
	Mitel	SIL4520	
	Motorola	MC14520	
	National	CD4520	
	SSS	SCL4520	
	TI	TP4520	
	Toshiba	TC4520	
CD4527	Motorola	MC14527	
	SSS	SCL4527	
CD4532	Fairchild	F4532	
	Motorola	MC14532	
	Toshiba	TC4532	
CD4555	Fairchild	F4555	
	Motorola	MC14555	
	SSS	SCL4555	
CD4556	Fairchild	F4556	
	Motorola	MC14556	
	SSS	SCL4556	
MW4104	Mostek	MK4027	

Rockwell, Microelectronic Div.

1103	**AMI**	**S1103A**	**634**
1604	EA	EA4096	
	Mostek	MK4096	

Scientific Micro Systems

SMS300	Signetics	8X300
SMS360	Signetics	8T32
SMS361	Signetics	8T33
SMS362	Signetics	8T36
SMS363	Signetics	8T35

SGS-ATES Semiconductor

Manufacturer Device	Replacement Source	Device	IC Master Page
HBF4001	RCA	CD4001	
	SSS	SCL4001	
HBF4002	RCA	CD4002	
	SSS	SCL4002	
HBF4007	RCA	CD4007,	
	SSS	SCL4007	
HBF4008	RCA	CD4008	
	SSS	SCL4008	
HBF4009	RCA	CD4009	
	SSS	SCL4009	
HBF4010	RCA	CD4010	
	SSS	SCL4010	
HBF4011	RCA	CD4011	
	SSS	SCL4011	
HBF4012	RCA	CD4012	
	SSS	SCL4012	
HBF4013	RCA	CD4013	
	SSS	SCL4013	
HBF4014	RCA	CD4014	
	SSS	SCL4014	
HBF4016	RCA	CD4016	
		CD4066	
	SSS	SCL4016	
HBF4017	RCA	CD4017	
	SSS	SCL4017	
HBF4020	RCA	CD4020	
	SSS	SCL4020	
HBF4021	RCA	CD4021	
	SSS	SCL4021	
HBF4022	RCA	CD4022	
	SSS	SCL4022	
HBF4023	RCA	CD4023	
	SSS	SCL4023	
HBF4024	RCA	CD4024	
	SSS	SCL4024	
HBF4025	RCA	CD4025	
	SSS	SCL4025	
HBF4027	RCA	CD4027	
	SSS	SCL4027	
HBF4028	RCA	CD4028	
HBF4029	RCA	CD4029	
	SSS	SCL4029	
HBF4035	RCA	CD4035	
	SSS	SCL4035	
HBF4040	RCA	CD4040	
	SSS	SCL4040	
L201	Sprague	ULN-2001	
L202	Sprague	ULN-2002	
L203	Sprague	ULN-2003	
M1024	ITT	SAA1024	
M1025	ITT	SAA1025	
TAA661	NPC	TAA661	
TAA930	NPC	TAA930	
TBA510	Fairchild	TBA510	
TBA520	Fairchild	TBA520	
TBA530	Fairchild	TBA530	
TBA540	Fairchild	TBA540	
TBA560	Fairchild	TBA560	
TBA641	Fairchild	µA706	
		TBA641	
TBA800	Fairchild	TBA800	
	NPC	TBA800	
TBA810	Fairchild	TBA810	
	Motorola	MC1384	
	RCA	CA810	
	SGS	TBA810	
	Signetics	TBA810	
TBA920	Fairchild	TBA920	
	NPC	TBA920	
TBA970	Fairchild	TBA970	
TBA990	Fairchild	TBA990	
TCA900	NPC	TCA900	

Signetics

µA709	Fairchild	µA709	
	Motorola	MC1709	
µA709	National	LM709	
	Raytheon	RC709	
		RM709	
	Teledyne S	709	
	TI	µA709	
µA710	Fairchild	µA710	
	Motorola	MC1710	
	National	LM710	
	Raytheon	RC710	
		RM710	
	Silicon G	SG710	
	Teledyne S	710	
	TI	µA710	
µA711	Fairchild	µA711	
	Motorola	MC1711	
	National	LM711	
	Raytheon	RC711	
		RM711	
	Silicon G	SG711	
	Teledyne S	711	
	TI	µA711	
µA723	AMD	723	
	Fairchild	µA723	
	Intersil	723	
	Motorola	MC1723	
	National	LM723	
	Raytheon	RC723	
		RM723	
	RCA	CA723	
	Silicon G	SG723	
	Teledyne S	723	
	TI	µA723	
µA733	AMD	733	
	Motorola	MC1733	
	National	LM733	
	Raytheon	RC733	
		RM733	
	Silicon G	SG733	
	TI	µA733	
µA740	Fairchild	µA740	
	Intersil	740	
	National	LH740	
µA741	**AD**	**AD741**	**575**
	AMD	741	
	Fairchild	µA741	
	Intersil	741	
	Motorola	MC1741	
	National	LM741	
	PMI	SSS741	
	Raytheon	RC741	
		RM741	
	RCA	CA741	
	Silicon G	SG741	
	Teledyne S	741	
	TI	µA741	
µA747	AMD	747	
	Fairchild	µA747	
	Motorola	MC1747	
	National	LM747	
	PMI	SSS747	
	Raytheon	RC747	
		RM747	
	RCA	CA747	
	Silicon G	SG747	
	Teledyne S	747	
	TI	µA747	
µA748	AMD	748	
	Fairchild	µA748	
	Intersil	748	
	Motorola	MC1748	
	National	LM748	
	Raytheon	RC748	
		RM748	
	RCA	CA748	
	Silicon G	SG748	
	Teledyne S	748	
	TI	µA748	
µA78G	Fairchild	µA78G	
µA78L05	Fairchild	µA78L05	
µA78L12	Fairchild	µA78L12	
µA78L15	Fairchild	µA78L15	
µA78L62	Fairchild	µA78L06	
µA78MG	Fairchild	µA78MG	
µA78M05	Fairchild	µA78M05	
µA78M06	Fairchild	µA78M06	
µA78M08	Fairchild	µA78M08	
µA78M12	Fairchild	µA78M12	
µA78M15	Fairchild	µA78M15	
µA78M20	Fairchild	µA78M20	
µA78M24	Fairchild	µA78M24	
µA7805	Fairchild	µA7805	
µA7806	Fairchild	µA7806	
µA7808	Fairchild	µA7808	
µA7812	Fairchild	µA7812	
µA7815	Fairchild	µA7815	
µA7818	Fairchild	µA7818	
µA7824	Fairchild	µA7824	
µA79G	Fairchild	µA79G	
µA79MG	Fairchild	µA79MG	
DM8880	National	DS8880	
LF155	National	LF155	
LF156	National	LF156	
LF157	National	LF157	
LF255	National	LF255	
LF256	National	LF256	
LF257	National	LF257	
LF355	National	LF355	
LF356	National	LF356	
LF357	National	LF357	
LM101	AMD	LM101	
	Fairchild	µA101	
	Intersil	LM101	
	Motorola	MLM101	
	RCA	CA101	
	Silicon G	SG101	
	Siliconix	LM101	
	Teledyne S	LM101	
	TI	LM101	
LM107	AMD	LM107	
	Fairchild	µA107	
	Intersil	LM107	
	Motorola	MLM107	
	Raytheon	LM107	
	RCA	CA107	
	Silicon G	SG107	
	TI	LM107	
LM108	AMD	LM108	
	Fairchild	µA108	
	Motorola	MLM108	
	Raytheon	LM108	
	RCA	CA108	
	Silicon G	SG108	
LM109	Fairchild	µA109	
	Motorola	MLM109	
	Silicon G	SG109	
	TI	LM109	
LM111	AMD	LM111	
	Motorola	MLM111	
	Silicon G	SG111	
	TI	LM111	
LM124	AMD	LM124	
	Motorola	MLM124	
	Silicon G	SG124	
	TI	LM124	
LM139	AMD	LM139	
	Motorola	MLM139	
	Silicon G	SG139	
	TI	LM139	
LM201	AMD	LM201	
	Fairchild	µA201	
	Intersil	LM201	
	Motorola	MLM201	
	RCA	CA201	
	Silicon G	SG201	
	Teledyne S	LM201	
	TI	LM201	
LM207	AMD	LM207	
	Fairchild	µA207	
	Intersil	LM207	
	Motorola	MLM207	
	Raytheon	LM207	
	RCA	CA207	

♦ Discontinued

Bold face device numbers indicate manufacturers' data is provided in the IC Master on the pages noted.

Signetics (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
LM207	Silicon G	SG207	
	TI	LM207	
LM208	AMD	LM208	
	Motorola	MLM208	
	Silicon G	SG208	
LM209	Fairchild	μA209	
	Motorola	MLM209	
	Raytheon	LM209	
	Silicon G	SG209	
	TI	LM209	
LM211	AMD	LM211	
	Motorola	MLM211	
	Silicon G	SG211	
	Teledyne S	LM211	
	TI	LM211	
LM224	AMD	LM224	
	Motorola	MLM224	
	Silicon G	SG224	
	TI	LM224	
LM239	AMD	LM239	
	Motorola	MLM239	
	Silicon G	SG239	
	TI	LM239	
LM301	AMD	LM301	
	Fairchild	μA301	
	Intersil	LM301	
	Motorola	MLM301	
	National	LM301	
	Raytheon	LM301	
	RCA	CA301	
	Silicon G	SG301	
	Teledyne S	LM301	
	TI	LM301	
LM307	AMD	LM307	
	Fairchild	μA307	
	Intersil	LM307	
	Motorola	MLM307	
	National	LM307	
	Raytheon	LM307	
	RCA	CA307	
	Silicon G	SG307	
	TI	LM307	
LM308	AMD	LM308	
	Fairchild	μA308	
	Motorola	MLM308	
	National	LM308	
	Raytheon	LM308	
	RCA	CA308	
	Silicon G	SG308	
LM309	Fairchild	μA309	
	Motorola	MLM309	
	Raytheon	LM309	
	Silicon G	SG309	
	TI	LM309	
LM311	AMD	LM311	
	Motorola	MLM311	
	Raytheon	LM311	
	Silicon G	SG311	
	Teledyne S	LM311	
	TI	SN72311	
LM324	AMD	LM324	
	Motorola	MLM324	
	Silicon G	SG324	
	TI	LM324	
LM329	TI	LM329	
LM339	AMD	LM339	
	Motorola	MLM339	
	Silicon G	SG339	
MC1456	Motorola	MC1456	
	Raytheon	RC1556	
	Silicon G	SG1456	
	TI	MC1456	
MC1458	Fairchild	MC1458	
	Motorola	MC1458	
	National	LM1458	
	Raytheon	RC1458	
	RCA	CA1458	
	Silicon G	SG1458	
MC1458	Teledyne S	1458	
	TI	MC1458	
MC1495	Silicon G	SG1595	
MC1496	Lithic Sys	LS1496	
	Motorola	MC1496	
	National	LM1496	
	Silicon G	SG1496	
MC1556	Motorola	MC1556	
	Raytheon	RM1556	
	Silicon G	SG1556	
MC1558	Motorola	MC1558	
	Raytheon	RM1558	
	RCA	CA1558	
	Silicon G	SG1558	
	TI	MC1558	
MC1596	Lithic Sys	LS1596	
	Motorola	MC1596	
	Silicon G	SG1596	
NE529	National	LM361	
NE531	Raytheon	RC4531	
NE536	Fairchild	μA740	
	Intersil	NE536	
NE555	AMD	NE555	
	Exar	XR555	
	Fairchild	μA555	
	Intersil	NE555	
	Lithic Sys	LS555	
	Motorola	MC1455	
	Raytheon	RC555	
	RCA	CA555	
	Silicon G	SG555	
	TI	NE555	
NE556	AMD	NE556	
	Exar	XR556	
	Fairchild	μA556	
	Motorola	MC3456	
	Raytheon	RC556	
	Silicon G	SG556	
	Teledyne S	556	
	TI	NE556	
NE565	Motorola	MLM565	
NE567	Exar	XR567	
NE592	Motorola	MC1733	
		NE592	
♦N1004	Motorola	MC1004	
♦N1006	Motorola	MC1006	
♦N1010	Motorola	MC1010	
♦N1011	Motorola	MC1011	
♦N1012	Motorola	MC1012	
♦N1013	Motorola	MC1013	
♦N1014	Motorola	MC1014	
♦N1015	Motorola	MC1015	
♦N1016	Motorola	MC1016	
♦N1017	Motorola	MC1017	
♦N1024	Motorola	MC1024	
♦N1025	Motorola	MC1025	
♦N1027	Motorola	MC1027	
♦N1033	Motorola	MC1033	
♦N1039	Motorola	MC1039	
♦N2010	Motorola	MC1160/236	
N3002	Intel	3002	
♦N5065	Motorola	MC1358	
	Sprague	ULN-2165	
♦N5070	Sprague	ULN-2124	
♦N5071	Fairchild	μA781	
	Sprague	ULN-2127	
♦N5072	Fairchild	μA746	
	Sprague	ULN-2114	
N5570	Fairchild	μA780	
♦N5595	Motorola	MC1495	
♦N5709	Signetics	μA709	
♦N5710	Signetics	μA710	
♦N5711	Signetics	μA711	
♦N5723	Signetics	μA723	
♦N5733	Signetics	μA733	
♦N5741	Signetics	μA741	
♦N5747	Signetics	μA747	
♦N5748	Signetics	μA748	
N8H16	National	DM54H20	
N8H70	ITT	ITT74H11	
	National	DM74H10	
N8H70	TI	SN74H11	
N8H80	ITT	ITT74H00	
	National	DM74H00	
	TI	SN74H00	
N8H90	ITT	ITT74H04	
	National	DM74H04	
	TI	SN74H04	
N8T09	Raytheon	RC8T09	
N8T10	National	DM8551	
	Raytheon	RC8T10	
	TI	SN74173	
N8T13	Fairchild	8T13	
	Motorola	MC8T13	
	National	DS7521	
	Raytheon	RC8T13	
N8T14	Fairchild	8T14	
	Motorola	MC8T14	
	National	DS75122	
	Raytheon	RC8T14	
N8T22	ITT	ITT74122	
	National	DM8601	
	Raytheon	RC8T22	
		RF8601	
	TI	SN74122	
N8T23	Fairchild	8T23	
	Motorola	MC8T23	
	National	DS75123	
	Raytheon	RC8T23	
	TI	SN75123	
N8T24	Fairchild	8T24	
	Motorola	MC8T24	
	National	DS75124	
	Raytheon	RC8T24	
	TI	SN75124	
N8T25	Motorola	MC6880	
	National	**DS3625**	**485**
N8T26	Motorola	MC8T26	
	National	DS8826	
	TI	N8T26	
N8T28	Motorola	MC8T28	
N8T34	National	DS8834	
N8T37	Motorola	MC3437	
	National	DS8837	
N8T38	Motorola	MC3438	
	National	DS8838	
N8T380	National	DS8836	
N8T51	National	DS8856	
N8T54	National	DM7448	
N8T59	National	DS8857	
N8T74	Fairchild	9374	
	National	DS8672	
N8T95	Motorola	MC8T95	
	National	DM8095	
N8T96	Motorola	MC8T96	
	National	DM8096	
N8T97	Motorola	MC8T97	
	National	DM8097	
N8T98	Motorola	MC8T98	
	National	DM8098	
		DN7098	
		DS8674	
N82S02	Raytheon	RC5330	
N82S06	Intersil	IM5523	
	MMI	6531	
	Raytheon	RC5340	
	TI	SN74S200A	
		SN74S201	
		SN74S301	
N82S07	Fairchild	93411	
	Intersil	IM5533	
	MMI	6530	
	TI	SN74S300	
		SN74S301	
N82S08	Fairchild	93415	
		93421	
	TI	SN74S309	
		SN74S314	
N82S10	Fairchild	93415	
	TI	SN74S314	
N82S11	Fairchild	93425	
	TI	SN74S214	
N82S110	TI	SN74S314	
N82S111	TI	SN74S214	
N82S116	MMI	6531	
	National	**DM74S206**	**751**
	TI	SN74S200A	
		SN74S201	
N82S117	**National**	**DM74S206**	**751**
	TI	SN74S300	
		SN74S301	
N82S123	**Harris**	**HM7603**	**682**
	Intersil	IM5610	
	MMI	6331	
	National	**DM8578**	**702**
	TI	SN74S288	
N82S124	Intersil	IM5610	
	TI	**SN74S387**	**861**
N82S126	Harris	HPROM1024A	
	Intel	**3601**	**695**
	MMI	5300	
		6300	
	National	**DM74S387**	**708**
	TI	**SN54S387**	**861**
		SN74S387	**861**
N82S129	Harris	HPROM1024	
	Intel	**3621-1**	**695**
	Intersil	IM5623	
	MMI	5301	
		6301	
	National	**DM74S287**	**708**
	TI	**SN54S287**	**861**
		SN74S287	**861**
N82S130	Fairchild	93436	
	Harris	**HM7620**	**682**
	MMI	6305	
	TI	SN74170	
N82S131	Fairchild	93446	
	Harris	**HM7621**	**682**
	MMI	6306	
	National	**DM74S571**	**710**
N82S136	**Harris**	**HM7642**	**682**
	Intel	**3605**	**699**
	MMI	6352	
	National	**DM74S572**	**702**
		DM74S572	**712**
N82S137	**Harris**	**HM7643**	**682**
	Intel	**3625**	**699**
	MMI	6353	
N82S140	**National**	**DM87S295**	**714**
N82S141	**National**	**DM87S296**	**714**
N82S16	Fairchild	93421	
	Intersil	IM5523	
	MMI	6531	
	National	**DM74S200**	**704**
	Raytheon	RC5340	
	TI	SN54S201	
		SN74S200A	
		SN74S201	
N82S17	Fairchild	93411	
	Intersil	IM5533	
	MMI	6530	
	National	**DM74S206**	**751**
	Raytheon	RC5330	
	TI	SN54S301	
		SN74S300	
		SN74S301	
N82S180	National	DM85S229	
N82S181	National	DM85S228	
N82S226	Fairchild	93416	
	Intersil	IM5603	
	MMI	6300	
	TI	SN54187	
		SN74187	
N82S229	**TI**	**SN74S287**	**861**
N82S23	AMD	AM27S09	
	Harris	**HM7602**	**682**
	MMI	6330	
	TI	**SN54S188**	**860**
		SN74S188	**860**
N82S230	TI	SN54S270	
		SN74S270	
N82S231	TI	SN54S370	

♦Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Signetics (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
N82S231	TI	SN74S370	
N82S24	Intersil	IM5600	
	TI	SN54S301	
N82S25	National	DM74S289	
	TI	SN74S289	
N82S26	Fairchild	93416	
	Intersil	IM5603	
	MMI	6300	
	TI	**SN74S387**	**861**
N82S29	Fairchild	93426	
	Intersil	IM5623	
	MMI	6301	
	TI	**SN54S287**	**861**
		SN74S287	**861**
N82S30	National	DM8312	
N82S41	National	DM74LS386	
N82S52	National	DM8301	
N82S80	National	DM74LS196	
N82S81	National	DM74LS197	
N82S90	National	DM74LS196	
	TI	SN74S196	
N82S91	National	DM74LS197	
	TI	SN74S197	
N8200	Raytheon	RC8200	
N8201	Raytheon	RC8201	
N8202	Raytheon	RC8202	
N8203	Raytheon	RC8203	
N8206	TI	SN74S200A	
		SN74S201	
N8207	TI	SN74S300	
		SN74S301	
N82147	National	DM74147	
	TI	SN74147	
N82148	National	DM74148	
	TI	SN74148	
N8223	Harris	HPROM8256	
	Intersil	IM5600	
	MMI	6330	
	National	**DM8577**	**702**
	TI	**SN74S188**	**860**
N8224	Intersil	IM5600	
	National	**DM7488**	**702**
	TI	SN7488	
N8225	AMD	3101	
	Intersil	IM5501	
	Motorola	MCM4064	
	Raytheon	RC8225	
	TI	SN74S289	
N8230	Hitachi	HD2549	
	ITT	ITT9312	
	Motorola	MC7230	
	National	DM8312	
	Raytheon	RC8230	
	TI	SN29312	
N8231	Motorola	MC7230	
	Raytheon	RC8231	
N8232	Motorola	MC7230	
	Raytheon	RC8232	
N8233	Motorola	MC8233	
	Raytheon	RC8233	
N8234	Motorola	MC8234	
	Raytheon	RC8234	
N8241	Hitachi	HD2526	
	Motorola	MC7241	
		MC7242	
	National	DM74LS386	
	Raytheon	RC8241	
N8242	Motorola	MC7242	
	Raytheon	RC8242	
	TI	SN74LS266	
N8250	Motorola	MC7250	
		MC7251	
	Raytheon	RC8250	
N8251	Hitachi	HD2536	
	Motorola	MC7250	
		MC7251	
	Raytheon	RC8251	
N8252	Motorola	MC7250	
N8252	Motorola	MC7251	
	National	DM8301	
	Raytheon	RC8252	
	TI	SN29301	
N8255	AMD	3101	
	Intersil	IM5501	
	MMI	6560	
	Motorola	MCM4064	
	Raytheon	RC8225	
	TI	SN74S289	
N8260	Motorola	MC7260	
	Raytheon	RC8260	
N8261	Hitachi	HD2562	
	Motorola	MC7261	
	Raytheon	RC8261	
N8262	Raytheon	RC8262	
N8263	Raytheon	RC8263	
N8264	Raytheon	RC8264	
N8266	Motorola	MC7266	
	Raytheon	RC8266	
N8267	Motorola	MC7267	
	Raytheon	RC8267	
N8268	ITT	ITT7480	
	Motorola	MC7268	
	TI	SN7480	
N8269	National	DM8200	
N8270	Motorola	MC7270	
	Raytheon	RC8270	
	TI	SN74178	
N8271	Motorola	MC7271	
	Raytheon	RC8271	
	TI	SN74179	
N8277	Motorola	MC7277	
	Raytheon	RC8277	
N8280	Motorola	MC7280	
	National	DM8280	
	Raytheon	RC8280	
	TI	SN74176	
N8281	Motorola	MC7281	
	National	DM8281	
	Raytheon	RC8281	
	TI	SN54177	
N8284	Motorola	MC7284	
	Raytheon	RC8284	
N8285	Motorola	MC7285	
	Raytheon	RC8285	
N8288	Motorola	MC7288	
	National	DM8288	
N8290	National	DM8290	
	Raytheon	RC8290	
	TI	SN74196	
N8291	National	DM8291	
	Raytheon	RC8291	
	TI	SN74197	
N8292	National	DM74LS196	
	TI	SN74LS196	
N8293	National	DM74LS197	
	TI	SN74LS197	
N8415	National	DM1800	
N8455	Motorola	MC7440	
	National	DM7440	
	TI	SN7440	
N8470	ITT	ITT7410	
	Motorola	MC7410	
	National	DM7410	
	TI	SN7410	
N8471	ITT	ITT7412	
	Motorola	MC7412	
	National	DM74LS12	
	TI	SN7412	
N8480	ITT	ITT7400	
	National	DM7400	
	TI	SN7400	
N8481	ITT	ITT7403	
	Motorola	MC7403	
	National	DM7403	
	TI	SN7403	
N8490	ITT	ITT7404	
	Motorola	MC7404	
	National	DM7404	
	TI	SN7404	
N8555	ITT	ITT7440	
N8806	ITT	ITT7460	
	Motorola	MC7460	
	National	DM7406	
	TI	SN7460	
N8808	ITT	ITT7430	
	Motorola	MC7430	
	National	DM7430	
	TI	SN7430	
N8813	National	DM7425	
N8815	National	DM7425	
	TI	SN7425	
N8824	Motorola	MC7474	
	TI	SN7474	
N8825	Motorola	MC7470	
	TI	SN7470	
N8828	ITT	ITT7474	
	Motorola	MC7479	
	National	DM7474	
	TI	SN7474	
N8829	Motorola	MC7472	
N8840	ITT	ITT7450	
	Motorola	MC7450	
	National	DM7451	
	TI	SN7450	
N8848	ITT	ITT74H74	
	Motorola	MC7453	
	TI	SN74H53	
N8859	National	DM7440	
N8875	Motorola	MC7427	
	National	DM7427	
	TI	SN7427	
N8881	ITT	ITT7401	
	Motorola	MC7401	
	National	DM7401	
	TI	SN7401	
N8890	ITT	ITT7404	
	National	DM7404	
	TI	SN7404	
N8891	ITT	ITT7405	
	National	DM7405	
	TI	SN7405	
SE529	National	LM161	
SE531	Raytheon	RM4531	
SE550	National	LM550	
SE555	AMD	SE555	
	Exar	XR555	
	Intersil	SE555	
	Lithic Sys	LS555	
	Motorola	MC1555	
	National	LM555	
	Raytheon	RM555	
	RCA	CA555	
	Silicon G	SG555	
	TI	SE555	
SE556	Motorola	MC3556	
	Raytheon	RM556	
	Silicon G	SG556	
	TI	SE556	
SE565	National	LM565	
SE566	National	LM566	
SE567	National	LM567	
SE592	Motorola	MC1733	
SN75107	AMD	SN75107	
	National	**DS75107**	**475**
	Raytheon	RC75107	
	TI	SN75107	
SN75108	AMD	SN75108	
	National	**DS75108**	**475**
	Raytheon	RC75108	
	TI	SN75108	
SN7520	National	DS7520	
	Silicon G	SG7520	
	TI	SN7520	
SN7521	National	DS7521	
	Silicon G	SG7521	
	TI	SN7521	
SN7522	National	DS7522	
	Silicon G	SG7522	
	TI	SN7522	
SN7523	National	DS7523	
SN7523	Silicon G	SG7523	
	TI	SN7523	
SN7524	Fairchild	7524	
	National	DS7524	
	Silicon G	SG7524	
	TI	SN7524	
SN7525	Fairchild	7525	
	National	DS7525	
	Silicon G	SG7525	
	TI	SN7525	
SN75450	Fairchild	75450	
	National	DS75450	
	Raytheon	RC75450	
	Silicon G	SG75450	
	TI	SN75450	
SN75451	Fairchild	75451	
	National	DS75451	
	Raytheon	RC75451	
	Silicon G	SG75451	
	TI	SN75451	
SP380	National	DS8640	
SU536	Intersil	SU536	
♦S5709	Signetics	μA709	
♦S5710	Signetics	μA710	
♦S5711	Signetics	μA711	
♦S5723	Signetics	μA723	
♦S5733	Signetics	μA733	
♦S5741	Signetics	μA741	
S7280	National	DM7280	
S7281	National	DM7281	
S7290	National	DM7290	
S7291	National	DM7291	
S8H16	National	DM54H20	
S8H70	National	DM54H10	
	TI	SN54H11	
S8H80	National	DM54H00	
	TI	SN54H00	
S8H90	National	DM54H04	
	TI	SN54H04	
S8T09	Raytheon	RM8T09	
S8T10	National	DM7551	
	Raytheon	RM8T10	
	TI	SN54173	
S8T13	Fairchild	8T13	
	Raytheon	RM8T13	
	TI	SN55121	
S8T14	Fairchild	8T14	
	Raytheon	RM8T14	
	TI	SN55122	
S8T22	Fairchild	9601	
	National	DM9601	
	Raytheon	RM8T22	
	TI	SN29601	
S8T23	Raytheon	RM8T23	
S8T24	Raytheon	RM8T24	
S8T54	National	DM5448	
S8T95	National	DM7095	
S8T96	National	DM7096	
S8T97	National	DM7097	
S8T98	National	DM7098	
S82LS29	**TI**	**SN54S287**	**861**
S82S06	Raytheon	RM5340	
	TI	SN54S201	
S82S07	Raytheon	RM5330	
	TI	SN54S301	
S82S115	Intel	M3624	
S82S123	**Harris**	**HM7603**	**682**
	MMI	5331	
	National	**DM7578**	**702**
	TI	SN54S288	
S82S126	**Harris**	**HM7610**	**682**
		HPROM1024A	
	MMI	5300	
	National	**DM54S387**	**708**
	TI	**SN54S387**	**861**
S82S129	**Harris**	**HM7611**	**682**
		HPROM1024	
	National	**DM54S287**	**708**
	TI	**SN54S287**	**861**
S82S130	**Harris**	**HM7620**	**682**
	MMI	5305	

♦ Discontinued

Bold face device numbers indicate manufacturers' data is provided in the IC Master on the pages noted.

Signetics (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
S82S131	**Harris**	**HM7621**	**682**
	MMI	5306	
	National	**DM54S571**	**710**
S82S136	**Harris**	**HM7642**	**682**
	MMI	5352	
	National	**DM54S572**	**702**
		DM54S572	**712**
S82S137	**Harris**	**HM7643**	**682**
	MMI	5353	
S82S140	**National**	**DM77S295**	**714**
S82S141	**National**	**DM77S296**	**714**
S82S16	**National**	**DM54S200**	**704**
	TI	SN54S201	
S82S17	**National**	**DM54S206**	**751**
	TI	SN54S301	
S82S180	National	DM75S229	
S82S181	National	DM75S228	
S82S226	TI	SN54187	
S82S229	**TI**	**SN54S287**	**861**
S82S23	**Harris**	**HM7602**	**682**
	MMI	5330	
	TI	**SN54S188**	**860**
S82S230	TI	SN54S270	
S82S231	TI	SN54S370	
S82S25	TI	SN54S289	
		SN54S301	
S82S26	AMD	82S26	
	TI	**SN54S387**	**861**
S82S30	Fairchild	93S12	
S82S41	National	DM54LS386	
S82S62	Fairchild	93S62	
S82S80	National	DM54LS196	
S82S81	National	DM54LS197	
S82S90	National	DM54LS196	
S82S91	National	DM54LS197	
S8200	Raytheon	RM8200	
S8201	Raytheon	RM8201	
S8202	Raytheon	RM8202	
S8203	Raytheon	RM8203	
S8207	TI	SN54S301	
S82147	National	DM54147	
S82148	National	DM54148	
S8223	Harris	HPROM8256	
	Intersil	IM5600	
		IM5600	
	MMI	5330	
	National	**DM7577**	**702**
	TI	**SN54S188**	**860**
S8224	**National**	**DM5488**	**702**
	TI	SN5488A	
S8225	Fairchild	93403	
	TI	SN54S289	
S8230	Fairchild	9312	
	National	DM9312	
	Raytheon	RM8230	
	TI	SN39312	
S8231	Fairchild	9313	
	Raytheon	RM8231	
S8241	National	DM54LS386	
	Raytheon	RM8241	
S8242	Fairchild	9386	
	Raytheon	RM8242	
	TI	SN54LS266	
S8250	Raytheon	RM8250	
S8251	Raytheon	RM8251	
S8252	Fairchild	9301	
	National	DM9301	
	Raytheon	RM8252	
	TI	SN39301	
S8260	Raytheon	RM8260	
S8261	Raytheon	RM8261	
S8262	Raytheon	RM8262	
S8263	Raytheon	RM8263	
S8264	Raytheon	RM8264	
S8266	Raytheon	RM8266	
S8267	Raytheon	RM8267	
S8268	TI	SN5480	
S8269	National	DM7200	
S8270	Fairchild	93178	
	Raytheon	RM8270	
	TI	SN54178	
S8271	Fairchild	93179	
	Raytheon	RM8271	
	TI	SN54179	
S8277	Fairchild	9328	
	Raytheon	RM8277	
S8280	Fairchild	93176	
	Raytheon	RM8280	
	TI	SN54176	
S8281	Fairchild	93177	
	Raytheon	RM8281	
	TI	SN54177	
S8288	National	DM7288	
S8290	Fairchild	93196	
	Raytheon	RM8290	
	TI	SN54196	
S8291	Fairchild	93197	
	Raytheon	RM8291	
	TI	SN54197	
S8292	National	DM54LS196	
	TI	SN54LS196	
S8293	National	DM54LS197	
	TI	SN54LS197	
S8455	National	DM5440	
	TI	SN5440	
S8470	National	DM5410	
	TI	SN5410	
S8471	National	DM54LS12	
	TI	SN5412	
S8480	National	DM5400	
	TI	SN5400	
S8481	National	DM5403	
	TI	SN5403	
S8490	National	DM5404	
	TI	SN5404	
S8806	National	DM5460	
	TI	SN5460	
S8808	National	DM5430	
	TI	SN5430	
S8815	National	DM5425	
	TI	SN5425	
S8828	National	DM5474	
	TI	SN5474	
S8840	National	DM5451	
	TI	SN5450	
S8848	National	DM54LS54	
	TI	SN54H53	
S8859	National	DM5440	
S8875	National	DM5427	
	TI	SN5427	
S8881	National	DM5401	
	TI	SN5401	
S8890	National	DM5404	
	TI	SN5404	
S8891	National	DM5405	
	TI	SN5405	
ULN2111	Motorola	MC1357	
	Sprague	ULN-2111	
10101	Motorola	MC10101	
10102	Motorola	MC10102	
10105	Motorola	MC10105	
10106	Motorola	MC10106	
10107	Motorola	MC10107	
10109	Motorola	MC10109	
10110	Motorola	MC10110	
10111	Motorola	MC10111	
10115	Motorola	MC10115	
10116	Motorola	MC10116	
10117	Motorola	MC10117	
10118	Motorola	MC10118	
10119	Motorola	MC10119	
10121	Motorola	MC10121	
10124	Motorola	MC10124	
10125	Motorola	MC10125	
10130	Motorola	MC10130	
10132	Motorola	MC10132	
10133	Motorola	MC10133	
10134	Motorola	MC10134	
10136	Motorola	MC10136	
10137	Motorola	MC10137	
10139	TI	SN10139	
10140	TI	SN10140	
10141	Motorola	MCM10141	
10144	Fairchild	F10410	
	TI	SN10144	
10145	Motorola	MCM10145	
	TI	SN10145	
10148	TI	SN10148	
♦10149	Motorola	MCM10149	
10160	Motorola	MC10160	
10161	Motorola	MC10161	
10162	Motorola	MC10162	
10164	Motorola	MC10164	
10171	Motorola	MC10171	
10172	Motorola	MC10172	
10173	Motorola	MC10173	
10174	Motorola	MC10174	
10175	Motorola	MC10175	
10176	Motorola	MC10176	
10181	Motorola	MC10181	
10210	Motorola	MC10210	
10211	Motorola	MC10211	
10212	Motorola	MC10212	
1103	**AMI**	**S1103**	**634**
	TI	TMS1103	
11031	Motorola	MC10131	
21F02	Intel	2102A	
21L02	AMD	91L02	
2101	Intel	2101	
2102	AMD	2102	
	Mostek	MK4102	
	National	**MM2102**	**759**
2111	Intel	2111	
2112	Intel	2112	
2115	**Intel**	**2115**	**683**
2125	**Intel**	**2125**	**683**
2352	SGS	M142	
2400	AMI	S8773	
2441	AMI	S8773	
2451	AMI	S8773	
2461	AMI	S8773	
2462	AMI	S8773	
♦25L01	Intersil	IM7512	
	Mostek	MK4007	
♦2501	**AMI**	**S4006**	**634**
	Intersil	IM7501	
2502	SGS	M141	
	Synertek	SY1402	
2503	AMI	S2503A	
	SGS	M136	
	Synertek	SY1403	
2504	SGS	M140	
	Synertek	SY1404	
2505	AMD	AM2505	
	AMI	S505A	
2512	AMD	AM2806	
	AMI	S2512A	
	Intersil	IM7712	
	Nortec	2512	
2513	GI	RO3-2513	
2517	AMD	1507	
2518	TI	TMS3122	
2521	AMD	AM2521	
	AMI	S2181	
	TI	TMS3128	
2522	AMI	S2181	
	TI	TMS3129	
2524	AMD	AM2807	
	AMI	S1685	
2525	AMD	AM2808	
	Intersil	IM7722	
2526	**AMI**	**S8564**	**634**
2527	Synertek	SY2527	
2532	AMI	S2181	
	Intersil	IM7780	
	Mostek	MK1007	
	TI	TMS3120	
2533	AMD	AM2833	
	Synertek	SY2533	
	TI	TMS3133	
2536	GI	AY3-1014	
		AY3-1015	
		AY5-1013	
	TI	TMS6011	
♦2548	Nortec	6003	
♦2554	SGS	M130	
2600	EA	4600	
♦2602	Intersil	IM7752	
	Mostek	MK4102	
	TI	TMS4033	
		TMS4035	
2604	RCA	MW4060	
2607	EA	EA2308A	
	Synertek	SY2308A	
2608	**AMI**	**S6830**	**659**
		S6830	**889**
		S6830	**925**
	Motorola	MCM6830	
2609	Motorola	MCM6570	
	Nitron	NC6570	
2616	Intel	2316B	
2617	AMD	9216	
2650	Intersil	2650	
2660	Mostek	4096	
2670	**National**	**MM5270**	**783**
2675	TI	4050	
3207	Fairchild	9607	
	ITT	ITT75361	
54H00	Fairchild	54H00	
		9H00	
	TI	SN54H00	
54LS00	**Raytheon**	**54LS00**	**210**
54LS01	**Raytheon**	**54LS01**	**212**
54LS02	**Raytheon**	**54LS02**	**214**
54LS03	**Raytheon**	**54LS03**	**212**
54LS04	**Raytheon**	**54LS04**	**210**
54LS05	**Raytheon**	**54LS05**	**212**
54LS10	**Raytheon**	**54LS10**	**210**
54LS109	**Raytheon**	**54LS109**	**251**
54LS112	**Raytheon**	**54LS112**	**232**
54LS113	**Raytheon**	**54LS113**	**232**
54LS114	**Raytheon**	**54LS114**	**237**
54LS12	**Raytheon**	**54LS12**	**212**
54LS136	**Raytheon**	**54LS136**	**253**
54LS138	**Raytheon**	**54LS138**	**254**
54LS139	**Raytheon**	**54LS139**	**254**
54LS151	**Raytheon**	**54LS151**	**256**
54LS153	**Raytheon**	**54LS153**	**258**
54LS158	**Raytheon**	**54LS158**	**262**
54LS160	**Raytheon**	**54LS160**	**264**
54LS161	**Raytheon**	**54LS161**	**264**
54LS162	**Raytheon**	**54LS162**	**264**
54LS163	**Raytheon**	**54LS163**	**264**
54LS174	**Raytheon**	**54LS174**	**275**
54LS175	**Raytheon**	**54LS175**	**275**
54LS181	**Raytheon**	**54LS181**	**277**
54LS190	**Raytheon**	**54LS190**	**283**
54LS191	**Raytheon**	**54LS191**	**283**
54LS192	**Raytheon**	**54LS192**	**291**
54LS193	**Raytheon**	**54LS193**	**291**
54LS194A	**Raytheon**	**54LS194A**	**299**
54LS195A	**Raytheon**	**54LS195A**	**302**
54LS196	**Raytheon**	**54LS196**	**305**
54LS197	**Raytheon**	**54LS197**	**305**
54LS20	**Raytheon**	**54LS20**	**210**
54LS251	**Raytheon**	**54LS251**	**309**
54LS253	**Raytheon**	**54LS253**	**312**
54LS257	**Raytheon**	**54LS257**	**315**
54LS26	**Raytheon**	**54LS26**	**222**
54LS28	**Raytheon**	**54LS28**	**223**
54LS283	Raytheon	54LS283	
54LS295A	**Raytheon**	**54LS295A**	**321**
54LS33	**Raytheon**	**54LS33**	**226**
54LS37	**Raytheon**	**54LS37**	**223**
54LS38	**Raytheon**	**54LS38**	**226**
54LS40	**Raytheon**	**54LS40**	**223**
54LS54	**Raytheon**	**54LS54**	**230**
54LS55	**Raytheon**	**54LS55**	**230**
54LS73	**Raytheon**	**54LS73**	**232**
54LS75	Raytheon	54LS75	
54LS76	**Raytheon**	**54LS76**	**232**

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Signetics (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
54LS78	**Raytheon**	**54LS78**	**237**
54LS83	**Raytheon**	**54LS83A**	**239**
54LS86	**Raytheon**	**54LS86**	**242**
54LS95B	Raytheon	54LS95B	
54S00	Fairchild	54S00	
		9S00	
	TI	SN54S00	
5400	Fairchild	5400	
		9N00	
	TI	SN5400	
72S180	National	DM85S229	
72S52	National	DM8301	
7293	National	DM74LS197	
74H00	Fairchild	74H00	
		9H00	
	Raytheon	74H00	
	TI	SN74H00	
74H01	Raytheon	74H01	
	TI	SN74H01	
74H04	Raytheon	74H04	
	TI	SN74H04	
74H05	Raytheon	74H05	
	TI	SN74H05	
74H10	Raytheon	74H10	
	TI	SN74H10	
74H11	Raytheon	74H11	
	TI	SN74H11	
74H20	Raytheon	74H20	
	TI	SN74H20	
74H22	Raytheon	74H22	
	TI	SN74H22	
74H40	Raytheon	74H40	
	TI	SN74H40	
74H74	Raytheon	74H74	
74LS00	**Raytheon**	**74LS00**	**210**
74LS01	**Raytheon**	**74LS01**	**212**
74LS02	**Raytheon**	**74LS02**	**214**
74LS03	**Raytheon**	**74LS03**	**212**
74LS04	**Raytheon**	**74LS04**	**210**
74LS05	**Raytheon**	**74LS05**	**212**
74LS08	**Raytheon**	**74LS08**	**215**
74LS09	**Raytheon**	**74LS09**	**217**
74LS10	**Raytheon**	**74LS10**	**210**
74LS107	**Raytheon**	**74LS107**	**232**
74LS109	**Raytheon**	**74LS109**	**251**
74LS11	**Raytheon**	**74LS11**	**215**
74LS112	**Raytheon**	**74LS112**	**232**
74LS113	**Raytheon**	**74LS113**	**232**
74LS114	**Raytheon**	**74LS114**	**237**
74LS12	**Raytheon**	**74LS12**	**212**
74LS136	**Raytheon**	**74LS136**	**253**
74LS138	**Raytheon**	**74LS138**	**254**
74LS139	**Raytheon**	**74LS139**	**254**
74LS14	**Raytheon**	**74LS14**	**218**
74LS15	**Raytheon**	**74LS15**	**217**
74LS151	**Raytheon**	**74LS151**	**256**
74LS152	**Raytheon**	**74LS152**	**256**
74LS153	**Raytheon**	**74LS153**	**258**
74LS157	**Raytheon**	**74LS157**	**262**
74LS158	**Raytheon**	**74LS158**	**262**
74LS160	**Raytheon**	**74LS160**	**264**
74LS161	**Raytheon**	**74LS161**	**264**
74LS162	**Raytheon**	**74LS162**	**264**
74LS163	**Raytheon**	**74LS163**	**264**
74LS164	**Raytheon**	**74LS164**	**271**
74LS170	Raytheon	74LS170	
74LS174	**Raytheon**	**74LS174**	**275**
74LS175	**Raytheon**	**74LS175**	**275**
74LS181	**Raytheon**	**74LS181**	**277**
74LS190	**Raytheon**	**74LS190**	**283**
74LS191	**Raytheon**	**74LS191**	**283**
74LS192	**Raytheon**	**74LS192**	**291**
74LS193	**Raytheon**	**74LS193**	**291**
74LS194A	**Raytheon**	**74LS194A**	**299**
74LS195A	**Raytheon**	**74LS195A**	**302**
74LS196	**Raytheon**	**74LS196**	**305**
74LS197	**Raytheon**	**74LS197**	**305**
74LS20	**Raytheon**	**74LS20**	**210**
74LS21	**Raytheon**	**74LS21**	**215**
74LS22	**Raytheon**	**74LS22**	**212**
74LS221	Raytheon	74LS221	
74LS251	**Raytheon**	**74LS251**	**309**
74LS253	**Raytheon**	**74LS253**	**312**
74LS257	**Raytheon**	**74LS257**	**315**
74LS26	**Raytheon**	**74LS26**	**222**
74LS266	**Raytheon**	**74LS266**	**253**
74LS27	**Raytheon**	**74LS27**	**214**
74LS28	**Raytheon**	**74LS28**	**223**
74LS295A	**Raytheon**	**74LS295A**	**321**
74LS30	**Raytheon**	**74LS30**	**210**
74LS32	**Raytheon**	**74LS32**	**225**
74LS33	**Raytheon**	**74LS33**	**226**
74LS37	**Raytheon**	**74LS37**	**223**
74LS38	**Raytheon**	**74LS38**	**226**
74LS386	**Raytheon**	**74LS386**	**242**
74LS40	**Raytheon**	**74LS40**	**223**
74LS42	**Raytheon**	**74LS42**	**227**
74LS51	**Raytheon**	**74LS51**	**230**
74LS54	**Raytheon**	**74LS54**	**230**
74LS55	**Raytheon**	**74LS55**	**230**
74LS670	Raytheon	74LS670	
74LS73	**Raytheon**	**74LS73**	**232**
74LS74	**Raytheon**	**74LS74**	**235**
74LS75	Raytheon	74LS75	
74LS76	**Raytheon**	**74LS76**	**232**
74LS78	**Raytheon**	**74LS78**	**237**
74LS83	Raytheon	74LS83	
74LS85	**Raytheon**	**74LS85**	**241**
74LS86	**Raytheon**	**74LS86**	**242**
74LS90	**Raytheon**	**74LS90**	**243**
74LS92	**Raytheon**	**74LS92**	**243**
74LS93	**Raytheon**	**74LS93**	**243**
74LS95B	Raytheon	74LS95B	
74S00	Fairchild	74S00	
		9S00	
	TI	SN74S00	
74S200	**National**	**DM74S200**	**704**
74S201	MMI	6531	
	TI	SN74S201	
7400	Fairchild	7400	
		9N00	
	Hitachi	HD2503	
	Raytheon	7400	
	TI	SN7400	
7401	Hitachi	HD2509	
	Raytheon	7401	
	TI	SN7401	
7402	Hitachi	HD2511	
	TI	SN7402	
7403	Hitachi	HD2528	
	Raytheon	7403	
	TI	SN7403	
7404	Hitachi	HD2522	
	Raytheon	7404	
	TI	SN7404	
7405	Hitachi	HD2523	
	Raytheon	7405	
	TI	SN7405	
7408	Hitachi	HD2550	
	Raytheon	7408	
	TI	SN7408	
7409	Raytheon	7409	
7410	Hitachi	HD2507	
	Raytheon	7410	
	TI	SN7410	
74107	Hitachi	HD2530	
	TI	SN74107	
7411	Raytheon	7411	
♦7412	Raytheon	7412	
74123	Raytheon	74123	
♦74136	Raytheon	74136	
74145	Raytheon	74145	
♦7415	Raytheon	7415	
74150	Raytheon	74150	
74151	Raytheon	74151	
74152	Raytheon	74152	
74153	Raytheon	74153	
74154	Raytheon	74154	
74155	Raytheon	74155	
74156	Raytheon	74156	
74157	Raytheon	74157	
74158	Raytheon	74158	
♦74159	Raytheon	74159	
74160	Raytheon	74160	
74161	Raytheon	74161	
74162	Raytheon	74162	
74163	Raytheon	74163	
74164	Raytheon	74164	
74165	Raytheon	74165	
74166	Raytheon	74166	
74170	Raytheon	74170	
74174	Raytheon	74174	
74175	Raytheon	74175	
74181	Raytheon	74181	
74182	Raytheon	74182	
74190	Raytheon	74190	
74191	Raytheon	74191	
74192	Raytheon	74192	
74193	Raytheon	74193	
74194	Raytheon	74194	
74195	Raytheon	74195	
74198	Raytheon	74198	
74199	Raytheon	74199	
7420	Hitachi	HD2504	
	TI	SN7420	
7421	Raytheon	7421	
♦7422	Raytheon	7422	
♦74283	Raytheon	74283	
7430	Hitachi	HD2508	
	TI	SN7430	
7440	Hitachi	HD2501	
	TI	SN7440	
♦7441	Hitachi	HD2518	
	TI	SN74141	
7442	Raytheon	7442	
7443	Raytheon	7443	
7444	Raytheon	7444	
7445	Raytheon	7445	
7451	Hitachi	HD2505	
	TI	SN7451	
7453	Hitachi	HD2512	
	TI	SN7453	
7454	Hitachi	HD2514	
	TI	SN7454	
7460	Hitachi	HD2502	
	TI	SN7460	
7470	Hitachi	HD2539	
	TI	SN7470	
7472	Hitachi	HD2529	
	TI	SN7472	
7473	Hitachi	HD2515	
	TI	SN7473	
7474	Hitachi	HD2510	
	Raytheon	7474	
	TI	SN7474	
7475	Hitachi	HD2517	
	TI	SN7475	
7476	Hitachi	HD2516	
	TI	SN7476	
♦7481	Raytheon	7481	
7483	Raytheon	7483	
7486	Raytheon	7486	
7488	TI	SN7488A	
7489	Hitachi	HD2502	
	Intersil	IM5501	
	Raytheon	7489	
	TI	SN7489	
7490	Hitachi	HD2519	
	TI	SN7490A	
7491	Hitachi	HD2524	
	TI	SN7491A	
7492	Hitachi	HD2521	
	TI	SN7492A	
7493	Hitachi	HD2520	
	TI	SN7493A	
7494	Hitachi	HD2533	
	TI	SN7494	
7495	Hitachi	HD2534	
	TI	SN7495A	
7496	Hitachi	HD2546	
7496	TI	SN7496	
7520	ITT	ITT7520	
	Motorola	MC7520	
	National	DS7520	
	Silicon G	SG7520	
7521	ITT	ITT7521	
	Motorola	MC7521	
	National	DS7521	
	Silicon G	SG7521	
7522	ITT	ITT7522	
	Motorola	MC7522	
	National	DS7522	
	Silicon G	SG7522	
7523	ITT	ITT7523	
	Motorola	MC7523	
	National	DS7523	
	Silicon G	SG7523	
7524	ITT	ITT7524	
	Motorola	MC7524	
	National	DS7524	
	Silicon G	SG7524	
7525	ITT	ITT7525	
	Motorola	MC7525	
	National	DS7525	
	Silicon G	SG7525	
7550	Hitachi	HD2506	
8T32	SMS	SMS360	
8T33	SMS	SMS361	
8T35	SMS	SMS363	
8T36	SMS	SMS362	
8X300	SMS	SMS300	
93410	Fairchild	93410	
	TI	SN54S301	
		SN74S301	

Silicon General

SG101	AMD	LM101
	Intersil	LM101
	Motorola	MLM101
	National	LM101
	RCA	CA101
		CA748
	Signetics	LM101
	Teledyne S	LM101
	TI	LM101
SG104	Motorola	MLM104
	TI	LM104
SG105	AMD	LM105
	Intersil	LM105
	Motorola	MLM105
	National	LM105
	Raytheon	LM105
	Teledyne S	LM105
	TI	LM105
SG107	AMD	LM107
	Intersil	LM107
	Motorola	MLM107
	National	LM107
	Raytheon	LM107
	RCA	CA107
	Signetics	LM107
	TI	LM107
SG108	AMD	LM108
	Intersil	LM108
	Motorola	MLM108
	National	LM108
	Raytheon	LM108
	RCA	CA108
	Signetics	LM108
SG109	Motorola	MLM109
	National	LM109
	Raytheon	LM109
	TI	LM109
SG110	AMD	LM110
	Intersil	LM110
	Motorola	MLM110
	National	LM110
SG111	AMD	LM111
	Intersil	LM111

♦ Discontinued

Bold face device numbers indicate manufacturers' data is provided in the IC Master on the pages noted.

Silicon General (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
SG111	Motorola	MLM111	
	National	LM111	
	Raytheon	LM111	
	RCA	CA111	
	Teledyne S	LM111	
	TI	LM111	
SG139	Motorola	MLM139	
SG1456	Motorola	MC1456	
	TI	MC1456	
SG1458	**Harris**	**HA-2655**	**580**
	Motorola	MC1458	
	PMI	SSS1458	
	Raytheon	RC1458	
	RCA	CA1458	
	Teledyne S	1458	
	TI	MC1458	
SG1488	AMD	MC1488	
	Exar	XR1488	
	National	DS1488	
	Raytheon	RC1488	
SG1489	AMD	MC1489	
	Exar	XR1489	
	National	DS1489	
	Raytheon	RC1489	
SG1495	Motorola	MC1495	
SG1496	Lithic Sys	LS1496	
	Motorola	MC1496	
	Signetics	MC1496	
SG1556	Motorola	MC1556	
	TI	MC1556	
SG1558	**Harris**	**HA-2650**	**581**
	Motorola	MC1558	
	PMI	SSS1558	
	Raytheon	RM1558	
	RCA	CA1558	
	Teledyne S	1558	
	TI	MC1558	
SG1595	Lithic Sys	LS1595	
	Motorola	MC1595	
SG1596	Lithic Sys	LS1596	
	Motorola	MC1596	
	Signetics	MC1496	
SG1741S	Motorola	SG1741S	
SG201	AMD	LM201	
	Intersil	LM201	
	Motorola	MLM201	
	National	LM201	
	RCA	CA201	
	Signetics	LM201	
	TI	LM201	
SG204	Motorola	MLM204	
SG205	AMD	LM205	
	Intersil	LM205	
	Motorola	MLM205	
	National	LM205	
	Raytheon	LM205	
	Teledyne S	LM205	
SG207	AMD	LM207	
	Intersil	LM207	
	Motorola	MLM207	
	National	LM207	
	Raytheon	LM207	
	RCA	CA207	
	TI	LM207	
SG208	AMD	LM208	
	Intersil	LM208	
	Motorola	MLM208	
	National	LM208	
	Raytheon	LM208	
	RCA	CA208	
SG209	Motorola	MLM209	
	National	LM209	
	TI	SG209	
SG210	AMD	LM210	
	Intersil	LM210	
	Motorola	MLM210	
	National	LM210	
SG211	AMD	LM211	
SG211	Intersil	LM211	
	Motorola	MLM211	
	National	LM211	
	Raytheon	LM211	
	RCA	CA211	
	Teledyne S	LM211	
	TI	LM211	
SG2501	Motorola	MC1468	
SG301	AMD	LM301	
	Motorola	MLM301	
	National	LM301	
	Raytheon	LM301	
	RCA	CA301	
	Signetics	LM301	
	Teledyne S	LM301	
	TI	LM301	
		LM301	
SG304	Motorola	MLM304	
	Raytheon	LM304	
	Teledyne S	LM304	
	TI	LM304	
SG3046	Lithic Sys	LA3046	
SG305	AMD	LM305	
	Motorola	MLM305	
	National	LM305	
	Raytheon	LM305	
	Teledyne S	LM305	
	TI	LM305	
SG307	AMD	LM307	
	Motorola	MLM307	
	National	LM307	
	Raytheon	LM307	
	RCA	CA307	
	Signetics	LM307	
	TI	LM307	
SG308	AMD	LM308	
	Motorola	MLM308	
	National	LM308	
	Raytheon	LM308	
	RCA	CA308	
SG3086	Motorola	MC3386	
SG309	Motorola	MLM309	
	National	LM309	
	Raytheon	LM309	
	TI	LM309	
SG310	Motorola	MLM310	
	National	LM310	
SG311	AMD	LM311	
	Motorola	MLM311	
	National	LM311	
	Raytheon	LM311	
	RCA	CA311	
	Teledyne S	LM311	
	TI	LM311	
SG339	Motorola	MLM339	
	RCA	CA339	
SG3501	Motorola	MC1468	
SG3821	Lithic Sys	LA3045	
SG3822	Lithic Sys	LA3026	
SG3886	Lithic Sys	LA3086	
SG555	Lithic Sys	LS555	
	Motorola	MC1455	
	Raytheon	RC555	
		RM555	
	RCA	CA555	
	TI	NE555	
		SE555	
SG709	Motorola	MC1709	
	National	LM709	
	Raytheon	RM709	
	Signetics	μA709	
	Teledyne S	709	
	TI	μA709	
SG710	Motorola	MC1710	
	National	LM710	
	Raytheon	RC710	
		RM710	
	Signetics	μA710	
	Teledyne S	710	
	TI	μA710	
SG711	Motorola	MC1711	
SG711	National	LM711	
	Raytheon	RC711	
		RM711	
	Signetics	μA711	
	Teledyne S	711	
	TI	μA711	
SG723	AMD	723	
	Intersil	723	
	Motorola	MC1723	
	National	LM723	
	Raytheon	RC723	
		RM723	
	RCA	CA723	
	Signetics	μA723	
	Teledyne S	723	
	TI	μA723	
SG733	AMD	733	
	Motorola	MC1733	
	Raytheon	RC733	
		RM733	
	Signetics	μA733	
	TI	μA733	
SG741	AMD	741	
	Motorola	MC1741	
	National	LM741	
	PMI	SSS741	
	Raytheon	RC741	
		RM741	
	RCA	CA741	
	Signetics	μA741	
	Teledyne S	741	
	TI	μA741	
SG747	AMD	747	
	Motorola	MC1747	
	National	LM747	
	PMI	SSS747	
	Raytheon	RC747	
		RM747	
	RCA	CA747	
	Teledyne S	747	
	TI	μA747	
SG748	AMD	748	
	Motorola	MC1748	
	Raytheon	RC748	
		RM748	
	RCA	CA748	
	Signetics	μA748	
	Teledyne S	748	
	TI	μA748	
SG7520	National	DS7520	
	Signetics	7520	
	TI	SN7520	
SG7521	National	DS7521	
	Signetics	7521	
	TI	SN7521	
SG7522	Motorola	MC7522	
	National	DS7522	
	Signetics	7522	
	TI	SN7522	
SG7523	Motorola	MC7523	
	National	DS7523	
	Signetics	7523	
	TI	SN7523	
SG7524	Motorola	MC7524	
	National	DS7524	
	Signetics	SN7524	
SG7525	Motorola	MC7525	
	National	DS7525	
	Signetics	7525	
	TI	SN7525	
SG7528	Motorola	MC7528	
	TI	SN7528	
SG7529	Motorola	MC7529	
	TI	SN7529	
SN7524	TI	SN7524	

Siliconix

Manufacturer Device	Replacement Source	Device	IC Master Page
DG126	Intersil	DG126	
	National	AH0126	
DG129	Intersil	DG129	
	National	AH0129	
DG133	Intersil	DG133	
	National	AH0133	
DG134	Intersil	DG134	
	National	AH0134	
DG139	Intersil	DG139	
	National	AH0139	
DG140	Intersil	DG140	
	National	AH0140	
DG142	Intersil	DG142	
	National	AH0142	
DG143	Intersil	DG143	
	National	AH0143	
DG144	Intersil	DG144	
	National	AH0144	
DG145	Intersil	DG145	
	National	AH0145	
DG146	Intersil	DG146	
	National	AH0146	
DG151	Intersil	DF151	
	National	AH0151	
DG153	Intersil	DG153	
	National	AH0153	
DG154	Intersil	DG154	
	National	AM0154	
DG163	Intersil	DG163	
	National	AM0163	
DG164	Intersil	DG164	
	National	AM0164	
DG180	Intersil	DG180	
DG181	Intersil	DG181	
DG182	Intersil	DG182	
	TI	TL182	
DG183	Intersil	DG183	
DG184	Intersil	DG184	
DG185	Intersil	DG185	
	TI	TL185	
DG186	Intersil	DG186	
DG187	Intersil	DG187	
DG188	Intersil	DG188	
	TI	TL188	
DG189	Intersil	DG189	
DG190	Intersil	DG190	
DG191	Intersil	DG191	
	TI	TL191	
DG200	**AD**	**AD7513**	**430**
DG506	**AD**	**AD7506**	**431**
	Harris	**HI506**	**432**
	Intersil	IH5060	
DG507	**AD**	**AD7507**	**431**
	DDC	1507	
DG509	**Harris**	**HI509A**	**432**
LD110	Intersil	LD110	
LD111	Intersil	LD111	
LD114	Intersil	LD114	
LM101	Motorola	MLM101	
	RCA	CA101	
	Teledyne S	LM101	
	TI	LM101	

SMC Microsystems Corp.

COM2017	**AMI**	**S1883**	**400**
		S1883	**401**
	Western	TR1602	
COM2502	GI	AY3-1014	
		AY3-1015	
	Western	TR1602	
COM2505	GI	AY5-1013	
COM5016	Western	BR1941	
KR3275	GI	AY5-2376	
KR3600	GI	AY5-3600	

Solid State Scientific

SCL4000	Harris	HD4000
	Mitel	SIL4000
	Motorola	MC14000

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Solid State Scientific (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
SCL4000	RCA	CD4000	
SCL4001	Harris	HD4001	
	Mitel	SIL4001	
		SIL4901	
	Motorola	MC14001	
	National	CD4001	
	RCA	CD4001	
SCL4002	Harris	HD4002	
	Motorola	MC14002	
	National	CD4002	
	RCA	CD4002	
SCL4006	Harris	HD4006	
	Motorola	MC14006	
	National	CD4006	
	RCA	CD4006	
SCL4007	Harris	HD4007	
	Mitel	SIL4007	
	Motorola	MC14007	
	National	CD4007	
	RCA	CD4007	
SCL4008	Harris	HD4008	
	RCA	CD4008	
SCL4009	Mitel	SIL4009	
	National	CD4009	
	RCA	CD4009	
SCL4010	Mitel	SIL4010	
	National	CD4010	
	RCA	CD4010	
SCL4011	Harris	HD4011	
	Mitel	SIL4011	
		SIL4911	
	National	CD4011	
	RCA	CD4011	
SCL4012	Harris	HD4012	
	Mitel	SIL4012	
		SIL4912	
	Motorola	MC14012	
	National	CD4012	
	RCA	CD4012	
SCL4013	Harris	HD4013	
	Mitel	SIL4013	
	Motorola	MC14013	
	National	CD4013	
	RCA	CD4013	
SCL4014	Harris	HD4014	
	Mitel	SIL4014	
	Motorola	MC14014	
	National	CD4014	
	RCA	CD4014	
SCL4015	Harris	HD4015	
	Mitel	SIL4015	
	Motorola	MC14015	
	National	CD4015	
	RCA	CD4015	
SCL4016	Mitel	SIL4016	
	Motorola	MC14016	
	National	CD4016	
	RCA	CD4016	
		CD4066	
SCL4017	Harris	HD4017	
	Mitel	SIL4017	
	Motorola	MC14017	
	National	CD4017	
	RCA	CD4017	
SCL4018	Harris	HD4018	
	Mitel	SIL4018	
	National	CD4018	
	RCA	CD4018	
SCL4019	Harris	HD4019	
	Mitel	SIL4019	
	National	CD4019	
	RCA	CD4019	
SCL4020	Harris	HD4020	
	Mitel	SIL4020	
	Motorola	MC14020	
	National	CD4020	
	RCA	CD4020	
SCL4021	Harris	HD4021	
SCL4021	Mitel	SIL4021	
	Motorola	MC14021	
	National	CD4021	
	RCA	CD4021	
SCL4022	Harris	HD4022	
	Motorola	MC14022	
	National	CD4022	
	RCA	CD4022	
SCL4023	Harris	HD4023	
	Mitel	SIL4023	
		SIL4923	
	Motorola	MC14023	
	National	CD4023	
	RCA	CD4023	
SCL4024	Harris	HD4024	
	Mitel	SIL4024	
	Motorola	MC14024	
	National	CD4024	
	RCA	CD4024	
SCL4025	Harris	HD4025	
	Mitel	SIL4025	
		SIL4925	
	Motorola	MC14025	
	National	CD4025	
	RCA	CD4025	
SCL4026	RCA	CD4026	
SCL4027	Harris	HD4027	
	Mitel	SIL4027	
	Motorola	MC14027	
	National	CD4027	
	RCA	CD4027	
SCL4028	Harris	HD4028	
	Mitel	SIL4028	
	National	CD4028	
	RCA	CD4028	
SCL4029	Harris	HD4029	
	Mitel	SIL4029	
	National	CD4029	
	RCA	CD4029	
SCL4030	Harris	HD4030	
	Mitel	SIL4030	
	National	CD4030	
	RCA	CD4030	
		CD4070	
SCL4033	RCA	CD4033	
SCL4034	RCA	CD4034	
SCL4035	Harris	HD4035	
	Mitel	SIL4035	
	National	CD4035	
	RCA	CD4035	
SCL4040	Harris	HD4040	
	Mitel	SIL4040	
	Motorola	MC14040	
	National	CD4040	
	RCA	CD4040	
SCL4041	RCA	CD4041	
SCL4042	Harris	HD4042	
	Mitel	SIL4042	
	National	CD4042	
	RCA	CD4042	
SCL4043	Harris	HD4043	
	Mitel	SIL4043	
	National	CD4043	
	RCA	CD4043	
SCL4044	Harris	HD4044	
	Mitel	SIL4043	
	National	CD4044	
	RCA	CD4044	
SCL4045	RCA	CD4045	
SCL4046	Mitel	SIL4046	
	RCA	CD4046	
SCL4049	Harris	HD4049	
	Mitel	SIL4049	
	National	CD4049	
	RCA	CD4049	
SCL4050	Harris	HD4050	
	Mitel	SIL4050	
	National	CD4050	
	RCA	CD4050	
SCL4051	Harris	HD4051	
	Mitel	SIL4051	
SCL4051	RCA	CD4051	
SCL4052	Harris	HD4052	
	Mitel	SIL4052	
	RCA	CD4052	
SCL4053	Harris	HD4053	
	Mitel	SIL4053	
	RCA	CD4053	
SCL4060	Mitel	SIL4060	
	RCA	CD4060	
SCL4066	Harris	HD4066	
	Mitel	SIL4066	
	National	CD4066	
	RCA	CD4066	
SCL4068	Mitel	SIL4068	
		SIL4968	
SCL4069	Mitel	SIL4069	
	RCA	CD4069	
SCL4070	Mitel	SIL4070	
	RCA	CD4070	
SCL4071	Mitel	SIL4071	
	RCA	CD4071	
SCL4072	Mitel	SIL4072	
	RCA	CD4072	
SCL4073	Mitel	SIL4073	
	RCA	CD4073	
SCL4075	Mitel	SIL4075	
	RCA	CD4075	
SCL4076	Mitel	SIL4076	
	RCA	CD4076	
SCL4077	Mitel	SIL4077	
SCL4078	Mitel	SIL4078	
		SIL4978	
SCL4081	Harris	HD4081	
	Mitel	SIL4081	
	RCA	CD4081	
SCL4082	Mitel	SIL4082	
	RCA	CD4082	
SCL4402	RCA	CD4048	
SCL4412	RCA	CD4068	
SCL4445	RCA	CD4045	
SCL4449	RCA	CD4069	
SCL4502	Mitel	SIL4502	
	RCA	CD4502	
SCL4508	Mitel	SIL4508	
SCL4510	Harris	HD14510	
	Mitel	SIL4510	
	National	CD4510	
	RCA	CD4510	
SCL4511	Mitel	SIL4511	
	National	CD4511	
	RCA	CD4511	
SCL4512	Mitel	SIL4512	
SCL4514	Mitel	SIL4514	
	RCA	CD4514	
SCL4515	Mitel	SIL4515	
	RCA	CD4515	
SCL4516	Harris	HD14516	
	Mitel	SIL4516	
	National	CD4516	
	RCA	CD4516	
SCL4518	Harris	HD14518	
	Mitel	SIL4518	
	National	CD4518	
	RCA	CD4518	
SCL4520	Harris	HD14520	
	Mitel	SIL4520	
	National	CD4520	
	RCA	CD4520	
SCL4527	RCA	CD4527	
SCL4528	Mitel	SIL4528	
	RCA	CD4098	
SCL4555	RCA	CD4555	
SCL4556	RCA	CD4556	
SCL4585	RCA	CD4063	
♦SCL5437	Mostek	MK50040	

Solitron Devices

Manufacturer Device	Replacement Source	Device	IC Master Page
CM4000	Harris	HD4000	
	Motorola	MC14000	
CM4000	RCA	CD4000	
	SSS	SCL4000	
CM4001	Harris	HD4001	
	Motorola	MC14001	
	National	CD4001	
	RCA	CD4001	
	SSS	SCL4001	
CM4002	Harris	HD4002	
	Motorola	MC14002	
	National	CD4002	
	RCA	CD4002	
CM4006	Harris	HD4006	
	Motorola	MC14006	
	National	CD4006	
	RCA	CD4006	
	SSS	SCL4006	
CM4007	Harris	HD4007	
	Motorola	MC14007	
	National	CD4007	
	RCA	CD4007	
	SSS	SCL4007	
CM4008	Harris	HD4008	
	Motorola	MC14008	
	RCA	CD4008	
	SSS	SCL4008	
CM4009	National	CD4009	
	RCA	CD4009	
	SSS	SCL4009	
CM4010	National	CD4010	
	RCA	CD4010	
	SSS	SCL4010	
CM4011	Harris	HD4011	
	Motorola	MC14011	
	National	CD4011	
	SSS	SCL4011	
CM4012	Harris	HD4012	
	Motorola	MC14012	
	National	CD4012	
	RCA	CD4012	
	SSS	SCL4012	
CM4013	Harris	HD4013	
	Motorola	MC14013	
	National	CD4013	
	RCA	CD4013	
	SSS	SCL4013	
CM4014	Harris	HD4014	
	Motorola	MC14014	
	National	CD4014	
	RCA	CD4014	
	SSS	SCL4014	
CM4015	Harris	HD4015	
	Motorola	MC14015	
	National	CD4015	
	RCA	CD4015	
	SSS	SCL4015	
CM4016	Motorola	MC14016	
	National	CD4016	
	RCA	CD4016	
		CD4066	
	SSS	SCL4016	
CM4017	Harris	HD4017	
	Motorola	MC14017	
	National	CD4017	
	RCA	CD4017	
	SSS	SCL4017	
CM4018	Harris	HD4018	
	National	CD4018	
	RCA	CD4018	
	SSS	SCL4018	
CM4019	Harris	HD4019	
	Motorola	MC14519	
	National	CD4019	
	RCA	CD4019	
	SSS	SCL4019	
CM4020	Harris	HD4020	
	Motorola	MC14020	
	National	CD4020	
	RCA	CD4020	
	SSS	SCL4020	
CM4021	Harris	HD4021	
	Motorola	MC14021	

♦ Discontinued

Bold face device numbers indicate manuracturers' data is provided in the IC Master on the pages noted.

Solitron Devices (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
CM4021	National	CD4021	
	RCA	CD4021	
	SSS	SCL4021	
CM4022	Harris	HD4022	
	Motorola	MC14022	
	National	CD4022	
	RCA	CD4022	
	SSS	SCL4022	
CM4023	Harris	HD4023	
	Motorola	MC14023	
	National	CD4023	
	RCA	CD4023	
	SSS	SCL4023	
CM4024	Harris	HD4024	
	Motorola	MC14024	
	National	CD4024	
	RCA	CD4024	
	SSS	SCL4024	
CM4025	Harris	HD4025	
	Motorola	MC14025	
	National	CD4025	
	RCA	CD4025	
	SSS	SCL4025	
CM4026	RCA	CD4026	
	SSS	SCL4026	
CM4027	Harris	HD4027	
	Motorola	MC14027	
	National	CD4027	
	RCA	CD4027	
	SSS	SCL4027	
CM4028	Harris	HD4028	
	Motorola	MC14028	
	National	CD4028	
	RCA	CD4028	
CM4029	Harris	HD4029	
	National	CD4029	
	RCA	CD4029	
	SSS	SCL4029	
CM4030	Harris	HD4030	
	National	CD4030	
	RCA	CD4030	
		CD4070	
	SSS	SCL4030	
CM4032	Motorola	MC14032	
	RCA	CD4032	
CM4033	RCA	CD4033	
	SSS	SCL4033	
CM4034	RCA	CD4034	
	SSS	SCL4034	
CM4035	Harris	HD4035	
	National	CD4035	
	RCA	CD4035	
	SSS	SCL4035	
CM4036	RCA	CD4036	
CM4037	RCA	CD4037	
CM4038	Motorola	MC14038	
	RCA	CD4038	
CM4039	RCA	CD4039	
CM4040	Harris	HD4040	
	Motorola	MC14040	
	National	CD4040	
	RCA	CD4040	
	SSS	SCL4040	
CM4041	RCA	CD4041	
	SSS	SCL4041	
CM4042	Harris	HD4042	
	Motorola	MC14042	
	National	CD4042	
	RCA	CD4042	
	SSS	SCL4042	
CM4043	Harris	HD4043	
	National	CD4043	
	RCA	CD4043	
	SSS	SCL4043	
CM4044	Harris	HD4044	
	National	CD4044	
	RCA	CD4044	
	SSS	SCL4044	
CM4045	RCA	CD4045	
CM4046	RCA	CD4046	
CM4047	RCA	CD4047	
CM4048	RCA	CD4048	
CM4049	Harris	HD4049	
	National	CD4049	
	RCA	CD4049	
	SSS	SCL4049	
CM4050	Harris	HD4050	
	National	CD4050	
	RCA	CD4050	
	SSS	SCL4050	
CM4051	RCA	CD4051	
	SSS	SCL4051	
CM4052	RCA	CD4052	
	SSS	SCL4052	
CM4053	RCA	CD4053	
	SSS	SCL4053	
CM4066	Harris	HD4066	
	National	CD4066	
	RCA	CD4066	
	SSS	SCL4066	
CM4068	RCA	CD4068	
CM4069	RCA	CD4069	
CM4070	RCA	CD4070	
CM4071	RCA	CD4071	
CM4073	RCA	CD4073	
CM4075	RCA	CD4075	
CM4076	RCA	CD4076	
CM4077	RCA	CD4077	
CM4078	RCA	CD4078	
CM4081	RCA	CD4081	
CM4510	National	CD4510	
	RCA	CD4510	
CM4511	National	CD4511	
	RCA	CD4511	
CM4514	RCA	CD4514	
CM4515	RCA	CD4515	
CM4516	National	CD4516	
CM4518	Harris	HD14518	
	National	CD4518	
	RCA	CD4518	
	SSS	SCL4518	
CM4520	Harris	HD14520	
	National	CD4520	
	RCA	CD4520	
MA2556	Mostek	MK4007	
MA2656	Mostek	MK4007	
MA3556	Mostek	MK4007	
MA3656	Mostek	MK4007	
UC4250	Intersil	LM4250	
	National	LM4250	
	Silicon G	SG4250	
UC4741	PMI	SSS741	
	RCA	CA741	
	Teledyne S	741	

Sprague Electric Company

Manufacturer Device	Replacement Source	Device	IC Master Page
UDN-5711	Signetics	UDN5711	
UDN-5712	Signetics	UDN5712	
UDN-5713	Signetics	UDN5713	
UDN-5714	Signetics	UDN5714	
ULN-2001	Fairchild	9665	
	Motorola	MC1411	
	SGS	L201	
	Signetics	ULN2001	
ULN-2002	Fairchild	9666	
	Motorola	MC1412	
	SGS	L202	
	Signetics	ULN2002	
ULN-2003	Fairchild	9667	
	Motorola	MC1413	
	SGS	L203	
	Signetics	ULN2003	
ULN-2004	Signetics	ULN2004	
ULN-2111	Fairchild	µA2136	
	Motorola	MC1357	
	National	LM2111	
	RCA	CA2111	
ULN-2114	Fairchild	µA746	
	RCA	CA3072	
ULN-2120	Fairchild	µA732	
ULN-2124	Fairchild	µA780	
	RCA	CA3070	
ULN-2125	RCA	CA3120	
ULN-2126	Fairchild	µA739	
	SGS	TBA231	
ULN-2127	Fairchild	µA781	
	RCA	CA3071	
ULN-2128	Fairchild	µA767	
ULN-2129	Motorola	MC1375	
♦ULN-2131	Fairchild	µA753	
ULN-2136	Fairchild	µA2136	
	Motorola	MC1356	
ULN-2137	Fairchild	µA720	
ULN-2165	Fairchild	µA3065	
	Motorola	MC1358	
ULN-2209	Fairchild	µA753	
ULN-2210	Motorola	MC1310	
	RCA	CA1310	
ULN-2211	Motorola	MC1310	
ULN-2224	Motorola	MC1324	
ULN-2244	Fairchild	µA758	
	RCA	CA758	
ULN-2262	Fairchild	µA787	
	RCA	CA3126	
ULN-2264	Fairchild	µA3064	
	Motorola	MC1364	
ULN-2266	RCA	CA3066	
ULN-2267	Fairchild	µA3067	
ULN-2269	RCA	CA3121	
ULN-2278	Fairchild	µA705	
ULN-2289	Fairchild	µA3089	
ULN-2298	Motorola	MC1398	
	RCA	CA1398	
ULN-2741	National	LM741	
	RCA	CA741	
	Teledyne S	741	
	TI	µA741	
♦ULN-2747	RCA	CA747	
	Teledyne S	747	
	TI	µA747	
ULN-3304	Micro Comp	MCC102	
ULN-3305	Micro Comp	MCC122	

Stewart-Warner Microcircuits

Manufacturer Device	Replacement Source	Device	IC Master Page
SW1800	Motorola	MC1800	
	TI	SN151800	
♦SW1801	Motorola	MC1801	
	TI	SN151801	
SW1802	Motorola	MC1802	
	TI	SN151802	
♦SW1805	Motorola	MC1805	
	TI	SN15805	
SW1806	Motorola	MC1806	
	TI	SN151806	
♦SW1807	Motorola	MC1807	
	TI	SN151807	
SW1808	Motorola	MC1808	
	TI	SN151808	
SW1810	Motorola	MC1810	
	TI	SN151810	
SW1812	Motorola	MC1812	
	TI	SN151812	
SW1814	Motorola	MC1814	
SW1900	Motorola	MC1900	
	TI	SN151900	
♦SW1901	Motorola	MC1901	
	TI	SN151901	
SW1902	Motorola	MC1902	
	TI	SN151902	
♦SW1905	Motorola	MC1905	
	TI	SN151905	
SW1906	Motorola	MC1906	
	TI	SN151906	
♦SW1907	Motorola	MC1907	
	TI	SN151907	
SW1908	Motorola	MC1908	
	TI	SN151908	
SW1910	Motorola	MC1910	
	TI	SN151910	
SW1912	Motorola	MC1912	
	TI	SN151912	
SW1914	Motorola	MC1914	
♦SW301	Motorola	MC301	
♦SW302	Motorola	MC302	
♦SW303	Motorola	MC303	
♦SW304	Motorola	MC304	
♦SW305	Motorola	MC305	
♦SW306	Motorola	MC306	
♦SW307	Motorola	MC307	
♦SW308	Motorola	MC308	
♦SW309	Motorola	MC309	
♦SW310	Motorola	MC310	
♦SW311	Motorola	MC311	
♦SW351	Motorola	MC351	
♦SW352	Motorola	MC352	
♦SW353	Motorola	MC353	
♦SW354	Motorola	MC354	
♦SW355	Motorola	MC355	
♦SW356	Motorola	MC356	
♦SW357	Motorola	MC357	
♦SW358	Motorola	MC358	
♦SW359	Motorola	MC359	
♦SW360	Motorola	MC360	
♦SW361	Motorola	MC361	
SW4001	RCA	CD4001	
SW4002	RCA	CD4002	
SW4011	RCA	CD4011	
SW4012	RCA	CD4012	
SW4013	RCA	CD4013	
SW4015	RCA	CD4015	
SW4016	RCA	CD4016	
		CD4066	
SW4017	RCA	CD4017	
SW4019	RCA	CD4019	
SW4020	RCA	CD4020	
SW4021	RCA	CD4021	
SW4023	RCA	CD4023	
SW4024	RCA	CD4024	
SW4025	RCA	CD4025	
SW4027	RCA	CD4027	
SW4028	RCA	CD4028	
SW4029	RCA	CD4029	
SW4030	RCA	CD4030	
		CD4070	
SW4049	RCA	CD4049	
SW4050	RCA	CD4050	
SW705-1	Motorola	MC953	
	TI	SN159093	
SW705-2	Motorola	MC853	
	TI	SN158093	
SW706-1	Motorola	MC952	
	TI	SN15952	
SW706-2	Motorola	MC852	
	TI	SN15852	
SW708-1	Motorola	MC956	
	TI	SN15956	
SW708-2	Motorola	MC856	
	TI	SN15856	
SW709-1	Motorola	MC955	
	TI	SN15955	
SW709-2	Motorola	MC855	
	TI	SN15855	
SW930-1	Motorola	MC930	
	TI	SN15930	
SW930-2	Motorola	MC830	
	TI	SN15830	
SW932-1	Motorola	MC932	
	TI	SN15932	
SW932-2	Motorola	MC832	
	TI	SN15832	
SW933-1	Motorola	MC933	
	TI	SN15933	
SW933-2	Motorola	MC833	
	TI	SN15833	
SW935-1	Motorola	MC940	
	TI	SN15935	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Manufacturer Device	Replacement Source	Device	IC Master Page
Stewart-Warner Microcircuits (cont'd)			
SW935-2	Motorola	MC840	
	TI	SN15835	
SW936-1	Motorola	MC936	
	TI	SN15936	
SW936-2	Motorola	MC836	
	TI	SN15836	
SW937-1	Motorola	MC937	
	TI	SN15937	
SW937-2	Motorola	MC837	
	TI	SN15837	
SW941-1	Motorola	MC941	
	TI	SN15941	
SW941-2	Motorola	MC841	
	TI	SN15841	
SW944-1	Motorola	MC944	
	TI	SN15944	
SW944-2	Motorola	MC844	
	TI	SN15844	
SW945-1	Motorola	MC945	
	TI	SN15945	
SW945-2	Motorola	MC845	
	TI	SN15845	
SW946-1	Motorola	MC946	
	TI	SN15946	
SW946-2	Motorola	MC846	
	TI	SN15846	
SW948-1	Motorola	MC948	
	TI	SN15948	
SW948-2	Motorola	MC848	
	TI	SN15848	
SW949-1	Motorola	MC949	
	TI	SN15949	
SW949-2	Motorola	MC849	
	TI	SN15849	
SW950-1	Motorola	MC950	
	TI	SN15950	
SW950-2	Motorola	MC850	
	TI	SN15850	
SW951-1	Motorola	MC951	
	TI	SN15951	
SW951-2	Motorola	MC851	
	TI	SN15851	
SW957-1	Motorola	MC957	
	TI	SN15957	
SW957-2	Motorola	MC857	
	TI	SN15857	
SW958-1	Motorola	MC958	
	TI	SN15958	
SW958-2	Motorola	MC858	
	TI	SN15858	
SW961-1	Motorola	MC961	
	TI	SN15961	
SW961-2	Motorola	MC861	
	TI	SN15861	
SW962-1	Motorola	MC962	
	TI	SN15962	
SW962-2	Motorola	MC892	
	TI	SN15862	
SW963-1	Motorola	MC963	
	TI	SN15963	
SW963-2	Motorola	MC863	
	TI	SN15863	
♦1001	Motorola	MC1001	
♦1004	Motorola	MC1004	
♦1006	Motorola	MC1006	
♦1007	Motorola	MC1007	
♦1010	Motorola	MC1010	
♦1011	Motorola	MC1011	
♦1013	Motorola	MC1013	
♦1014	Motorola	MC1014	
♦1015	Motorola	MC1015	
♦1016	Motorola	MC1016	
♦1017	Motorola	MC1017	
♦1018	Motorola	MC1018	
♦1019	Motorola	MC1019	
♦1020	Motorola	MC1020	
♦1021	Motorola	MC1021	
♦1024	Motorola	MC1024	
♦1025	Motorola	MC1025	
♦1029	Motorola	MC1029	
♦1030	Motorola	MC1030	
♦1031	Motorola	MC1031	
♦1033	Motorola	MC1033	
♦1201	Motorola	MC1201	
♦1202	Motorola	MC1202	
♦1203	Motorola	MC1203	
♦1204	Motorola	MC1204	
♦1205	Motorola	MC1205	
♦1206	Motorola	MC1206	
♦1207	Motorola	MC1207	
♦1208	Motorola	MC1208	
♦1209	Motorola	MC1209	
♦1210	Motorola	MC1210	
♦1211	Motorola	MC1211	
♦1213	Motorola	MC1213	
♦1214	Motorola	MC1214	
♦1215	Motorola	MC1215	
♦1216	Motorola	MC1216	
♦1217	Motorola	MC1217	
♦1218	Motorola	MC1218	
♦1219	Motorola	MC1219	
♦1220	Motorola	MC1220	
♦1221	Motorola	MC1221	
♦1224	Motorola	MC1224	
♦1225	Motorola	MC1225	
♦1230	Motorola	MC1230	
♦1231	Motorola	MC1231	
♦1233	Motorola	MC1233	
Synertek			
SY1103	**AMI**	**S1103A**	**634**
SY2101	RCA	MW4101	
SY2111	RCA	MW4111	
SY2112	RCA	MW4112	
SY2670	**National**	**MM5270**	**783**
SY5280	RCA	MW4060	
SY6502	Mostek	MCS6502	
SY6503	Mostek	MCS6503	
SY6504	Mostek	MCS6504	
SY6505	Mostek	MCS6505	
SY6520	Mostek	MCS6520	
SY6522	Mostek	MCS6522	
SY6530	Mostek	MCS6530	
SY6532	Mostek	MCS6532	
Teledyne Crystalonics			
CDR125	Siliconix	D125	
Teledyne Philbrick			
1321	Datel	AM-462	
	Harris	**HA-2625**	**580**
1322	Datel	AM-452	
	Harris	**HA-2525**	**580**
1323	**Harris**	**HA-2705**	**580**
1324	**Harris**	**HA-2505**	**580**
1430	Datel	AM-500	
1431	Harris	HA-2065A	
4551	Datel	MXD-807	
4552	Datel	MX-1606	
4856	Datel	SHM-IC-1	
	Harris	**HA-2425**	**580**
Teledyne Semiconductor			
LM101	**AD**	**AD101**	**575**
	AMD	LM101	
	Fairchild	μA101	
	Intersil	LM101	
	Motorola	MLM101	
	National	LM101	
	RCA	CA101	
LM101	Signetics	LM101	
	Silicon G	SG101	
	Siliconix	LM101	
	TI	LM101	
LM104	Motorola	MLM104	
	Silicon G	SG104	
	TI	LM104	
LM105	AMD	LM105	
	Fairchild	μA105	
	Intersil	LM105	
	Motorola	MLM105	
	National	LM105	
	Raytheon	LM105	
	Silicon G	SG105	
	TI	LM105	
♦LM107	AMD	LM107	
	Fairchild	μA107	
	Intersil	LM107	
	Motorola	MLM107	
	National	LM107	
	Raytheon	LM107	
	RCA	CA107	
	Signetics	LM107	
	Silicon G	SG107	
	TI	LM107	
♦LM108	**AD**	**AD108**	**575**
	Motorola	MLM108	
	RCA	CA108	
	Silicon G	SG108	
LM111	AMD	LM111	
	Fairchild	μA111	
	Intersil	LM111	
	Motorola	MLM111	
	Raytheon	LM111	
	RCA	CA111	
	Signetics	LM111	
	Silicon G	SG111	
	TI	LM111	
LM124	Motorola	MLM124	
	Raytheon	LM124	
	RCA	CA124	
	Signetics	LM124	
	Silicon G	SG124	
	TI	LM124	
LM139	Motorola	MLM139	
	Raytheon	LM139	
	RCA	CA139	
	Silicon G	SG139	
	TI	LM139	
LM201	**AD**	**AD201**	**575**
	AMD	LM201	
	Fairchild	μA201	
	Intersil	LM201	
	Motorola	MLM201	
	National	LM201	
	RCA	CA201	
	Signetics	LM201	
	Silicon G	SG201	
	TI	LM201	
LM204	Fairchild	μA204	
	Motorola	MLM204	
	Raytheon	LM204	
	Silicon G	SG204	
	TI	LM204	
LM205	AMD	LM205	
	Fairchild	μA205	
	Intersil	LM205	
	Motorola	MLM205	
	National	LM205	
	Raytheon	LM205	
	Silicon G	SG205	
	TI	LM205	
♦LM207	AMD	LM207	
	Fairchild	μA207	
	Intersil	LM207	
	Motorola	MLM207	
	Raytheon	LM207	
	RCA	CA207	
	Signetics	LM207	
	Silicon G	SG207	
	TI	LM207	
LM208	Motorola	MLM208	
	National	LM208	
	RCA	CA208	
	Silicon G	SG208	
LM211	AMD	LM211	
	Fairchild	μA211	
	Intersil	LM211	
	Motorola	MLM211	
	National	LM211	
	Raytheon	LM211	
	RCA	CA211	
	Signetics	LM211	
	Silicon G	SG211	
	TI	LM211	
LM224	Motorola	MLM224	
	Raytheon	LM224	
	RCA	CA224	
	Signetics	LM224	
	Silicon G	SG224	
	TI	LM224	
LM239	Motorola	MLM239	
	Raytheon	LM239	
	RCA	CA239	
	Silicon G	SG239	
	TI	LM239	
LM301	**AD**	**AD301**	**575**
	AMD	LM301	
	Fairchild	μA301	
	Intersil	LM301	
	Motorola	MLM301	
	National	LM301	
	RCA	CA301	
	Signetics	LM301	
	Silicon G	SG301	
	TI	LM301	
LM304	Fairchild	μA304	
	Motorola	MLM304	
	Raytheon	LM304	
	Silicon G	SG304	
	TI	LM304	
LM305	AMD	LM305	
	Fairchild	μA305	
	Intersil	LM305	
	Motorola	MLM305	
	National	LM305	
	Silicon G	SG305	
	TI	LM305	
♦LM307	AMD	LM307	
	Fairchild	μA307	
	Intersil	LM307	
	Motorola	MLM307	
	National	LM307	
	Raytheon	LM307	
	RCA	CA307	
	Signetics	LM307	
	Silicon G	SG307	
	TI	LM307	
♦LM308	AMD	LM308	
	Fairchild	μA308	
	Motorola	MLM308	
	National	LM308	
	Signetics	LM308	
	Silicon G	SG308	
LM311	AMD	LM311	
	Fairchild	μA311	
	Intersil	LM311	
	Motorola	MLM311	
	National	LM311	
	Raytheon	LM311	
	RCA	CA311	
	Signetics	LM311	
	Silicon G	SG311	
	TI	LM311	
LM324	Motorola	MLM324	
	National	LM324	
	Raytheon	LM324	
	RCA	CA324	
	Signetics	LM324	
	Silicon G	SG324	
	TI	LM324	
♦LM339	National	LM339	

♦ Discontinued

Bold face device numbers indicate manuracturers' data is provided in the IC Master on the pages noted.

Teledyne Semiconductor (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
LM339	RCA	CA339	
	Silicon G	SG339	
	TI	LM339	
♦LM376	Fairchild	μA376	
♦MM54C00	Harris	HD54C00	
♦MM54C02	Harris	HD54C02	
	National	MM54C02	
♦MM54C04	Harris	HD54C04	
	National	MM54C04	
♦MM54C10	Harris	HD54C10	
	National	MM54C10	
♦MM54C107	Harris	HD54C107	
	National	MM54C107	
♦MM54C151	Harris	HD54C151	
	National	MM54C151	
♦MM54C154	Harris	HD54C154	
	National	MM54C154	
♦MM54C157	Harris	HD54C157	
	National	MM54C157	
♦MM54C160	Harris	HD54C160	
	National	MM54C160	
♦MM54C161	Harris	HD54C161	
	National	MM54C161	
♦MM54C162	Harris	HD54C162	
	National	MM54C162	
♦MM54C163	Harris	HD54C163	
	National	MM54C163	
♦MM54C164	Harris	HD54C164	
	National	MM54C164	
♦MM54C173	Harris	HD54C173	
	National	MM54C173	
♦MM54C192	Harris	HD54C192	
	National	MM54C192	
♦MM54C193	Harris	HD54C193	
	National	MM54C193	
♦MM54C195	Harris	HD54C195	
♦MM54C20	Harris	HD54C20	
	National	MM54C20	
MM54C200	**National**	**MM54C200**	**808**
♦MM54C42	Harris	HD54C42	
	National	MM54C42	
♦MM54C48	National	MM54C48	
♦MM54C73	Harris	HD54C73	
	National	MM54C73	
♦MM54C74	Harris	HD54C74	
	National	MM54C74	
♦MM54C76	Harris	HD54C76	
	National	MM54C76	
♦MM54C86	Harris	HD54C86	
	National	MM54C86	
♦MM54C89	Harris	HD54C89	
	National	**MM54C89**	**805**
♦MM54C95	Harris	HD54C95	
	National	MM54C95	
MM74C00	Harris	HD74C00	
	National	MM74C00	
	RCA	CD4011	
MM74C02	Harris	HD74C02	
	National	MM74C02	
	RCA	CD4001	
MM74C04	Harris	HD74C04	
	National	MM74C04	
	RCA	CD4069	
MM74C10	Harris	HD74C10	
	National	MM74C10	
	RCA	CD4023	
MM74C107	Harris	HD74C107	
	National	MM74C107	
♦MM74C14	National	MM74C14	
MM74C151	Harris	HD74C151	
	National	MM74C151	
MM74C154	Harris	HD74C154	
	National	MM74C154	
MM74C157	Harris	HD74C157	
	National	MM74C157	
MM74C160	Harris	HD74C160	
	National	MM74C160	
MM74C161	Harris	HD74C161	
	National	MM74C161	
MM74C162	Harris	HD74C162	
	National	MM74C162	
MM74C163	Harris	HD74C163	
	National	MM74C163	
MM74C164	Harris	HD74C164	
	National	MM74C164	
MM74C173	Harris	HD74C173	
	National	MM74C173	
	RCA	CD4076	
MM74C192	Harris	HD74C192	
	National	MM74C192	
	RCA	CD40192	
MM74C193	Harris	HD74C193	
	National	MM74C193	
	RCA	CD40193	
MM74C195	Harris	HD74C195	
	National	MM74C195	
MM74C20	Harris	HD74C20	
	National	MM74C20	
	RCA	CD4012	
♦MM74C200	Harris	HD74C200	
	National	**MM74C200**	**808**
MM74C42	Harris	HD74C42	
	National	MM74C42	
	RCA	CD4028	
♦MM74C48	Harris	HD74C48	
	National	MM74C48	
MM74C73	Harris	HD74C73	
	National	MM74C73	
MM74C74	Harris	HD74C74	
	National	MM74C74	
	RCA	CD4013	
MM74C76	Harris	HD74C76	
	National	MM74C76	
	RCA	CD4027	
♦MM74C86	Harris	HD74C86	
	National	MM74C86	
♦MM74C89	Harris	HD74C89	
	National	**MM74C89**	**805**
MM74C95	Harris	HD74C95	
	National	MM74C95	
TP1301	**AD**	**AD509**	**574**
TP1322	**AD**	**AD509**	**574**
TP301	**AD**	**AD507**	**574**
TP321	**AD**	**AD507**	**574**
1458	Fairchild	μA1458	
	Harris	**HA-2655**	**580**
	Motorola	MC1458	
	National	LM1458	
	Raytheon	RC1458	
	RCA	CA1458	
	Signetics	MC1458	
	Silicon G	SG1458	
	TI	MC1458	
1558	Fairchild	μA1558	
	Harris	**HA-2650**	**581**
	Motorola	MC1558	
	National	LM1558	
	RCA	CA1458	
	Signetics	MC1558	
	Silicon G	SG1558	
	TI	MC1558	
♦555	Exar	XR555	
	Lithic Sys	LS555	
	Motorola	MC1455	
	National	LM555	
	Silicon G	SG555	
	TI	NE555	
		SE555	
556	Exar	XR556	
	Motorola	MC3456	
	Silicon G	SG556	
	TI	NE556	
		SE556	
558	Silicon G	SG558	
709	Fairchild	μA709	
	Motorola	MC1709	
	Raytheon	RC709	
	Signetics	μA709	
709	TI	μA709	
710	Fairchild	μA710	
	Motorola	MC1710	
	National	LM710	
	Raytheon	RC710	
	RCA	CA710	
	Signetics	μA710	
	Silicon G	SG710	
	TI	μA710	
711	Fairchild	μA711	
	Motorola	MC1711	
	National	LM711	
	Raytheon	RC711	
	RCA	CA711	
	Silicon G	SG711	
	TI	μA711	
723	AMD	723	
	Intersil	723	
	Motorola	MC1723	
	National	LM723	
	Raytheon	RC723	
	Silicon G	SG723	
	TI	μA723	
741	**AD**	**AD741**	**575**
	AMD	741	
	Fairchild	μA741	
	Intersil	741	
	Motorola	MC1741	
	National	LM741	
	Raytheon	RC741	
	RCA	CA741	
	Signetics	μA741	
	Silicon G	SG741	
	TI	μA741	
747	AMD	747	
	Motorola	MC1747	
	National	LM747	
	Raytheon	RC747	
	RCA	CA747	
	Signetics	μA747	
	Silicon G	SG747	
748	Intersil	748	
	Motorola	MC1748	
	National	LM748	
	Raytheon	RC748	
	RCA	CA748	
	Signetics	μA748	
	TI	μA748	
8700	Datel	ADC-EK8B	
8701	Datel	ADC-EK10B	
8702	Datel	ADC-EK12B	
911A	Lithic Sys	LS171	
911B	Lithic Sys	LS271	
911C	Lithic Sys	LS371	

AEG-Telefunken

TCA830	SGS	TCA830
TDA440	SGS	TDA440

Texas Instruments

μA702	Fairchild	μA702
	Motorola	MC1712
	Raytheon	RC702
		RM702
μA709	Fairchild	μA709
	Motorola	MC1709
	National	LM709
	Raytheon	RC709
		RM709
	Signetics	μA709
	Teledyne S	709
μA710	Fairchild	μA710
	Motorola	MC1710
	National	LM710
	Raytheon	RC710
		RM710
	Signetics	μA710
μA710	Silicon G	SG710
	Teledyne S	710
μA711	Fairchild	μA711
	Motorola	MC1711
	National	LM711
	Raytheon	RC711
		RM711
	Signetics	μA711
	Silicon G	SG711
	Teledyne S	711
μA723	AMD	723
	Fairchild	μA723
	Intersil	723
	Motorola	MC1723
	National	LM723
	Raytheon	RC723
		RM723
	Signetics	μA723
	Silicon G	SG723
	Teledyne S	723
μA733	AMD	733
	Fairchild	μA733
	Motorola	MC1733
	National	LM733
	Raytheon	RC733
		RM733
	Signetics	μA733
	Silicon G	SG733
μA741	AMD	741
	Fairchild	μA741
	Intersil	741
	Motorola	MC1741
	National	LM741
	PMI	OP-02
		PM741
		SSS741
	Raytheon	RC741
		RM741
	RCA	CA741
	Signetics	μA741
	Silicon G	SG741
	Teledyne S	741
μA747	AMD	747
	Fairchild	μA747
	Motorola	MC1747
	National	LM747
	PMI	PM747
		SSS747
	Raytheon	RC747
		RM747
	RCA	CA747
	Silicon G	SG747
	Teledyne S	747
μA748	AMD	748
	Fairchild	μA748
	Intersil	748
	Motorola	MC1748
	National	LM748
	Raytheon	RC748
		RM748
	RCA	CA748
	Signetics	μA748
	Silicon G	SG748
	Teledyne S	748
μA777	Fairchild	μA777
	Intersil	777
	Silicon G	SG777
LM101	AMD	LM101
	Fairchild	μA101
	Intersil	LM101
	Motorola	MLM101
	National	LM101
	RCA	CA101
	Signetics	LM101
	Silicon G	SG101
	Teledyne S	LM101
LM104	Motorola	MLM104
	Silicon G	SG104
LM105	AMD	LM105
	Intersil	LM105
	Motorola	MLM105

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Manufacturer Device	Replacement Source	Device	IC Master Page
Texas Instruments (cont'd)			
LM105	National	LM105	
	Raytheon	LM105	
	Silicon G	SG105	
	Teledyne S	LM105	
LM106	AMD	LM106	
LM107	AMD	LM107	
	Fairchild	μA107	
	Intersil	LM107	
	Motorola	MLM107	
	National	LM107	
	Raytheon	LM107	
	RCA	CA107	
	Signetics	LM107	
	Silicon G	SG107	
LM111	AMD	LM111	
	Intersil	LM111	
	National	LM111	
	Raytheon	LM111	
	RCA	CA111	
	Signetics	LM111	
	Silicon G	SG111	
	Teledyne S	LM111	
LM301	AMD	LM301	
	Fairchild	μA301	
	Intersil	LM301	
	Motorola	MLM301	
	National	LM301	
	Raytheon	LM301	
	RCA	CA301	
	Signetics	LM301	
	Silicon G	SG301	
	Teledyne S	LM301	
LM304	Fairchild	μA304	
	Motorola	MLM304	
	Silicon G	SG304	
		SG304	
LM305	AMD	LM305	
	Fairchild	μA305	
	Intersil	LM305	
	Motorola	MLM305	
	Raytheon	LM305	
	Silicon G	SG305	
	Teledyne S	LM305	
LM306	AMD	LM306	
LM307	AMD	LM307	
	Fairchild	μA307	
	Intersil	LM307	
	Motorola	MLM307	
	National	LM307	
	Raytheon	LM307	
	RCA	CA307	
	Signetics	LM307	
	Silicon G	SG307	
LM311	AMD	LM311	
	Fairchild	μA311	
	Intersil	LM311	
	Motorola	MLM311	
	Raytheon	LM311	
	RCA	CA311	
	Signetics	LM311	
	Silicon G	SG311	
	Teledyne S	LM311	
LM376	Fairchild	μA376	
MC1458	Fairchild	μA1458	
	Harris	**HA-2655**	**580**
	Motorola	MC1458	
	National	LM1458	
	PMI	OP-14	
		SSS1458	
	Raytheon	RC1458	
		RC4558	
	RCA	CA1458	
	Signetics	MC1458	
	Silicon G	SG1458	
	Teledyne S	1458	
MC1558	Fairchild	μA1558	
	Harris	**HA-2650**	**581**
	Motorola	MC1558	
MC1558	National	LM1558	
	PMI	PM1558	
		SSS1558	
	Raytheon	RM1558	
		RM4558	
	RCA	CA1558	
	Silicon G	SG1558	
	Teledyne S	1558	
NE555	AMD	NE555	
	Fairchild	μA555	
	Intersil	NE555	
	Lithic Sys	LS555	
	Motorola	MC1455	
	Raytheon	RC555	
	RCA	CA555	
	Signetics	NE555	
	Silicon G	SG555	
	Teledyne S	555	
NE556	Fairchild	μA556	
	Motorola	MC3456	
	Silicon G	SG556	
RC4136	Exar	XR4136	
	Raytheon	**RC4136**	**588**
RC4558	Exar	XR4558	
	Motorola	MC4558	
	Raytheon	RC4558	
RM4136	Exar	XR4136	
	Raytheon	**RC4136**	**588**
RM4558	Motorola	MC4558	
	Raytheon	RM4558	
SE555	Intersil	SE555	
	Lithic Sys	LS555	
	Motorola	MC1555	
	Raytheon	RM555	
	RCA	CA555	
	Signetics	SE555	
	Silicon G	SG555	
SM54LS75	Raytheon	54LS75	
SM54L72	National	DM54L72	
♦SN10101	Motorola	MC10101	
♦SN10102	Motorola	MC10102	
♦SN10104	Motorola	MC10104	
♦SN10105	Motorola	MC10105	
♦SN10106	Motorola	MC10106	
♦SN10107	Motorola	MC10107	
♦SN10109	Motorola	MC10109	
♦SN10110	Motorola	MC10110	
♦SN10111	Motorola	MC10111	
♦SN10115	Motorola	MC10115	
♦SN10116	Motorola	MC10116	
♦SN10117	Motorola	MC10117	
♦SN10118	Motorola	MC10118	
♦SN10119	Motorola	MC10119	
♦SN10121	Motorola	MC10121	
♦SN10130	Motorola	MC10130	
♦SN10131	Motorola	MC10131	
♦SN10133	Motorola	MC10133	
SN10147	Fairchild	F10405	
♦SN10160	Motorola	MC10160	
♦SN10161	Motorola	MC10161	
SN10175	Motorola	MC10175	
♦SN10179	Motorola	MC10179	
♦SN10181	Motorola	MC10181	
SN151800	Motorola	MC1800	
	National	DM1800	
	SW	SW1800	
SN151801	Motorola	MC1801	
	National	DM1801	
SN151802	Motorola	MC1802	
	SW	SW1802	
SN151803	Motorola	MC1803	
SN151804	Motorola	MC1804	
	SW	SW1804	
SN151805	Motorola	MC1805	
SN151806	Motorola	MC1806	
	SW	SW1806	
SN151807	Motorola	MC1807	
SN151808	Motorola	MC1808	
	SW	SW1808	
SN151809	Motorola	MC1809	
SN151810	Motorola	MC1810	
SN151810	SW	SW1810	
SN151811	Motorola	MC1811	
SN151812	Motorola	MC1812	
	SW	SW1812	
SN151900	Motorola	MC1900	
	SW	SW1900	
SN151901	Motorola	MC1901	
SN151902	Motorola	MC1902	
	SW	SW1902	
SN151903	SW	SW1903	
SN151904	Motorola	MC1904	
	SW	SW1904	
SN151905	Motorola	MC1905	
SN151906	Motorola	MC1906	
	SW	SW1906	
SN151907	Motorola	MC1907	
SN151908	Motorola	MC1908	
	SW	SW1908	
SN151909	Motorola	MC1909	
SN151910	Motorola	MC1910	
	SW	SW1910	
SN151911	Motorola	MC1911	
SN151912	Motorola	MC1912	
	SW	SW1912	
SN158093	Motorola	MC853	
	National	DM9093	
	SW	SW705	
		SW8093	
SN158094	Motorola	MC856	
	National	DM9094	
	SW	SW708	
SN158097	Motorola	MC855	
	National	DM9097	
	SW	SW709	
		SW8097	
SN158099	Motorola	MC852	
	National	DM9099	
	SW	SW706	
		SW9099	
SN15830	Hitachi	HD2204	
	Motorola	MC830	
	National	DM930	
	SW	SW930	
SN15831	Motorola	MC831	
	SW	SW931	
SN15832	Hitachi	HD2201	
	Motorola	MC832	
	National	DM932	
	SW	SW932	
SN15833	Hitachi	HD2202	
	Motorola	MC833	
	National	DM933	
	SW	SW933	
SN15834	Motorola	MC834	
SN15835	Motorola	MC840	
	National	DM935	
	SW	SW935	
SN15836	Hitachi	HD2206	
	Motorola	MC836	
	National	DM936	
	SW	SW936	
SN15837	Motorola	MC837	
	National	DM937	
	SW	SW937	
SN15838	Motorola	MC835	
	SW	SW938	
SN15844	Hitachi	HD2209	
	Motorola	MC844	
	National	DM944	
	SW	SW844	
		SW944	
SN15845	Hitachi	HD2205	
	Motorola	MC845	
	National	DM945	
	SW	SW945	
SN15846	Hitachi	HD2203	
	Motorola	MC846	
	National	DM946	
	SW	SW946	
SN15848	Motorola	MC848	
	National	DM948	
SN15848	SW	SW948	
SN15849	Motorola	MC849	
	National	DM949	
	SW	SW949	
SN15850	Motorola	MC850	
	SW	SW950	
SN15851	Motorola	MC851	
	SW	SW951	
SN15857	Motorola	MC857	
	National	DM957	
	SW	SW957	
SN15858	Motorola	MC858	
	National	DM958	
	SW	SW958	
SN15861	Motorola	MC861	
	National	DM961	
	SW	SW961	
SN15862	Hitachi	HD2207	
	Motorola	MC862	
	National	DM962	
	SW	SW962	
SN15863	Motorola	MC863	
	National	DM963	
	SW	SW963	
SN159093	Motorola	MC953	
	Raytheon	RM993	
	SW	SW705	
SN159094	Motorola	MC956	
	Raytheon	RM994	
	SW	SW708	
SN159097	Motorola	MC955	
	Raytheon	RM997	
	SW	SW709	
SN159099	Motorola	MC952	
	Raytheon	RM999	
	SW	SW706	
SN15930	Motorola	MC930	
	Raytheon	RM930	
	SW	SW930	
SN15931	Motorola	MC931	
	Raytheon	RM931	
	SW	SW931	
SN15932	Motorola	MC932	
	Raytheon	RM932	
	SW	SW932	
SN15933	Motorola	MC933	
	Raytheon	RM933	
	SW	SW933	
SN15934	Motorola	MC934	
	Raytheon	RM934	
SN15935	Motorola	MC940	
	Raytheon	RM935	
	SW	SW935	
SN15936	Motorola	MC936	
	Raytheon	RM936	
	SW	SW936	
SN15937	Motorola	MC937	
	Raytheon	RM937	
	SW	SW937	
SN15938	Motorola	MC935	
SN15941	SW	SW941	
SN15944	Motorola	MC944	
	Raytheon	RM944	
	SW	SW944	
SN15945	Motorola	MC945	
	Raytheon	RM945	
	SW	SW945	
SN15946	Motorola	MC946	
	Raytheon	RM946	
	SW	SW946	
SN15948	Motorola	MC948	
	Raytheon	RM948	
	SW	SW948	
SN15949	Motorola	MC949	
	Raytheon	RM949	
	SW	SW949	
SN15950	Motorola	MC950	
	Raytheon	RM950	
	SW	SW950	
SN15951	Motorola	MC951	
	Raytheon	RM951	

♦ Discontinued

Bold face device numbers indicate manufacturers' data is provided in the IC Master on the pages noted.

Texas Instruments (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
SN15951	SW	SW951	
SN15957	Motorola	MC957	
	SW	SW957	
SN15958	Motorola	MC958	
	SW	SW958	
SN15961	Motorola	MC961	
	Raytheon	RM961	
	SW	SW961	
SN15962	Motorola	MC962	
	Raytheon	RM962	
	SW	SW962	
SN15963	Motorola	MC963	
	Raytheon	RM963	
	SW	SW963	
SN29000	Fairchild	9000	
	ITT	ITT74104	
SN29001	Fairchild	9001	
	ITT	ITT74105	
		ITT9001	
SN29002	ITT	ITT9002	
	National	DM9002	
SN29003	ITT	ITT9003	
	National	DM9003	
SN29004	National	DM9004	
SN29005	ITT	ITT9005	
	National	DM9005	
SN29006	National	DM9006	
SN29008	ITT	ITT9008	
	National	DM9008	
SN29009	ITT	ITT9009	
	National	DM9009	
SN29012	ITT	ITT9012	
	National	DM9012	
SN29016	ITT	ITT9016	
	National	DM9016	
SN29024	National	DM8024	
SN29300	AMD	9300	
	National	DM8300	
	Raytheon	RM9300	
SN29301	AMD	9301	
	Fairchild	9301	
	National	DM8301	
		DM9301	
SN29308	AMD	9308	
	Fairchild	9308	
	Raytheon	RC9308	
		RM9308	
SN29309	AMD	9309	
	Fairchild	9309	
	National	DM8309	
SN29310	AMD	9310	
	National	DM8310	
	Raytheon	RM9310	
SN29311	AMD	9311	
	National	DM8311	
	Raytheon	RM9311	
SN29312	AMD	9312	
	ITT	ITT9312	
	National	DM8312	
	Raytheon	RC9312	
		RM9312	
SN29316	AMD	9316	
	National	DM8316	
	Raytheon	RM9316	
SN29318	AMD	9318	
	National	DM8318	
SN29322	AMD	9322	
	National	DM8322	
SN29334	National	DM8334	
SN29601	AMD	9601	
	ITT	ITT9601	
	Motorola	MC9601	
	National	DM8601	
	Raytheon	RF9601	
SN29602	National	DM8602	
	Raytheon	RM9322	
SN39000	Fairchild	9000	
SN39001	Fairchild	9001	
SN39024	National	DM9024	
SN39300	National	DM9300	
SN39301	Fairchild	9301	
	National	DM9301	
SN39308	Fairchild	9308	
SN39309	Fairchild	9309	
	National	DM9309	
SN39310	National	DM9310	
SN39311	National	DM9311	
SN39312	Fairchild	9312	
	National	DM9312	
SN39316	National	DM9316	
SN39318	National	DM9318	
SN39322	National	DM9322	
SN39334	National	DM9334	
SN39601	National	DM9601	
SN39602	National	DM9602	
SN429301	ITT	ITT9301	
♦SN52L022	TI	TL022M	
♦SN52L044	TI	TL044M	
♦SN52101	TI	LM101	
SN52104	TI	LM104	
♦SN52105	TI	LM105	
♦SN52106	TI	LM106	
♦SN52107	TI	LM107	
♦SN52108	AMD	LM108	
	Intersil	LM108	
	Motorola	MLM108	
	National	LM108	
	Raytheon	LM108	
	RCA	CA108	
	Silicon G	SG108	
♦SN52109	TI	LM109	
SN52110	AMD	LM110	
	Intersil	LM110	
	Motorola	MLM110	
	National	LM110	
	Silicon G	SG110	
♦SN52111	TI	LM111	
♦SN52118	TI	LM118	
SN52197	Signetics	S8291	
♦SN52506	TI	TL506	
♦SN52510	TI	TL510	
♦SN52514	TI	TL514	
♦SN52555	TI	SE555	
♦SN52558	TI	MC1558	
♦SN52702	TI	TL702	
♦SN52702A	TI	μA702	
♦SN52709	TI	μA709	
♦SN52710	TI	TL710	
♦SN52711	TI	μA711	
♦SN52723	TI	μA723	
♦SN52733	TI	μA733	
♦SN52741	TI	μA741	
♦SN52747	TI	μA747	
♦SN52748	TI	μA748	
♦SN52771	Signetics	MC1556	
♦SN52777	TI	μA777	
♦SN52810	TI	TL810	
♦SN52811	TI	TL811	
♦SN52820	TI	TL820	
SN54H00	Fairchild	54H00	
		9H00	
	National	DM54H00	
	Raytheon	54H00	
	Signetics	54H00	
SN54H01	Fairchild	54H01	
		9H01	
	National	DM54H01	
	Raytheon	54H01	
	Signetics	54H01	
SN54H04	Fairchild	54H04	
		9H04	
	National	DM54H04	
	Raytheon	54H04	
	Signetics	54H04	
SN54H05	Fairchild	54H05	
		9H05	
	National	DM54H05	
	Raytheon	54H05	
	Signetics	54H05	
SN54H10	Fairchild	54H10	
		9H10	
	National	DM54H10	
	Raytheon	54H10	
	Signetics	54H10	
SN54H101	Fairchild	54H101	
		9H101	
	Signetics	54H101	
SN54H102	Fairchild	54H102	
		9H102	
	Signetics	54H102	
SN54H103	Fairchild	54H103	
		9H103	
	National	DM54H103	
SN54H106	Fairchild	54H106	
		9H106	
	National	DM54H106	
	Signetics	54H106	
SN54H108	Fairchild	54H108	
		9H108	
	National	DM54H108	
	Signetics	54H108	
SN54H11	National	DM54H11	
	Raytheon	54H11	
	Signetics	54H11	
SN54H183	Fairchild	54H183	
		93H183	
SN54H20	Fairchild	54H20	
		9H20	
	National	DM54H20	
	Raytheon	54H20	
	Signetics	54H20	
SN54H21	Fairchild	54H21	
		9H21	
	National	DM54H21	
	Signetics	54H21	
SN54H22	Fairchild	54H22	
		9H22	
	National	DM54H22	
	Raytheon	54H22	
	Signetics	54H22	
SN54H30	Fairchild	54H30	
		9H30	
	National	DM54H30	
	Signetics	54H30	
SN54H40	Fairchild	54H40	
		9H40	
	National	DM54H40	
	Raytheon	54H40	
	Signetics	54H40	
SN54H50	Fairchild	54H50	
		9H50	
	National	DM54H50	
	Signetics	54H50	
SN54H51	Fairchild	54H51	
		9H51	
	National	DM54H51	
	Signetics	54H51	
SN54H52	Fairchild	54H52	
		9H52	
	National	DM54H52	
	Signetics	54H52	
SN54H53	Fairchild	54H53	
		9H53	
	National	DM54H53	
	Signetics	54H53	
SN54H54	Fairchild	54H54	
		9H54	
	National	DM54H54	
	Signetics	54H54	
SN54H55	Fairchild	54H55	
		9H55	
	National	DM54H55	
	Signetics	54H55	
SN54H60	Fairchild	54H60	
		9H60	
	National	DM54H60	
	Signetics	54H60	
SN54H61	Fairchild	54H61	
		9H61	
	National	DM54H61	
SN54H61	Signetics	54H61	
SN54H62	Fairchild	54H62	
		9H62	
	National	DM54H62	
	Signetics	54H62	
SN54H71	Fairchild	54H71	
		9H71	
	National	DM54H71	
	Signetics	54H71	
SN54H72	Fairchild	54H72	
		9H72	
	National	DM54H72	
	Signetics	54H72	
SN54H73	Fairchild	54H73	
		9H73	
	National	DM54H73	
	Signetics	54H73	
SN54H74	Fairchild	54H74	
		9H74	
	National	DM54H74	
	Raytheon	54H74	
	Signetics	54H74	
SN54H76	Fairchild	54H76	
		9H76	
	National	DM54H76	
	Signetics	54H76	
SN54H78	Fairchild	54H78	
		9H78	
	National	DM54H78	
SN54H87	Fairchild	54H87	
		93H87	
SN54LS00	Fairchild	54LS00	
	National	DM54LS00	
	Raytheon	**54LS00**	**210**
	Signetics	54LS00	
SN54LS01	National	DM54LS01	
	Raytheon	**54LS01**	**212**
	Signetics	54LS01	
SN54LS02	Fairchild	54LS02	
	Raytheon	**54LS02**	**214**
	Signetics	54LS02	
SN54LS03	Fairchild	54LS03	
	National	DM54LS03	
	Raytheon	**54LS03**	**212**
	Signetics	54LS03	
SN54LS04	Fairchild	54LS04	
	National	DM54LS04	
	Raytheon	**54LS04**	**210**
	Signetics	54LS04	
SN54LS05	Fairchild	54LS05	
	Raytheon	**54LS05**	**212**
	Signetics	54LS05	
SN54LS08	Fairchild	54LS08	
	Raytheon	**54LS08**	**215**
	Signetics	54LS08	
SN54LS09	Fairchild	54LS09	
	Raytheon	**54LS09**	**217**
SN54LS10	Fairchild	54LS10	
	National	DM54LS10	
	Raytheon	**54LS10**	**210**
	Signetics	54LS10	
SN54LS107	**Raytheon**	**54LS107**	**232**
	Signetics	54LS107	
SN54LS109	Fairchild	54LS109	
	Raytheon	**54LS109**	**251**
	Signetics	54LS109	
SN54LS11	Fairchild	54LS11	
	Raytheon	**54LS11**	**215**
	Signetics	54LS11	
SN54LS112	Fairchild	54LS112	
	Raytheon	**54LS112**	**232**
	Signetics	54LS112	
SN54LS113	Fairchild	54LS113	
	Raytheon	**54LS113**	**232**
	Signetics	54LS113	
SN54LS114	Fairchild	54LS114	
	Raytheon	**54LS114**	**237**
	Signetics	54LS114	
SN54LS12	National	DM54LS12	
	Raytheon	**54LS12**	**212**
	Signetics	54LS12	

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

Texas Instruments (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
SN54LS122	Raytheon	54LS122	
SN54LS123	AMD	SN54LS123	
	Raytheon	54LS123	
SN54LS125	Fairchild	54LS125	
SN54LS126	Fairchild	54LS126	
SN54LS132	Fairchild	54LS132	
	Signetics	54LS132	
SN54LS136	Fairchild	54LS136	
	Raytheon	**54LS136**	**253**
	Signetics	54LS136	
SN54LS138	AMD	SN54LS138	
	Fairchild	54LS138	
	Raytheon	**54LS138**	**254**
	Signetics	54LS138	
SN54LS139	AMD	SN54LS139	
	Fairchild	54LS139	
	Raytheon	**54LS139**	**254**
	Signetics	54LS139	
SN54LS14	Fairchild	54LS14	
	Raytheon	**54LS14**	**218**
	Signetics	54LS14	
SN54LS145	Signetics	54LS145	
SN54LS148	AMD	SN54LS148	
SN54LS15	Fairchild	54LS15	
	Raytheon	**54LS15**	**217**
	Signetics	54LS15	
SN54LS151	AMD	SN54LS151	
	Fairchild	54LS151	
	Raytheon	**54LS151**	**256**
	Signetics	54LS151	
SN54LS152	Fairchild	54LS152	
	Raytheon	**54LS152**	**256**
SN54LS153	AMD	SN54LS153	
	Fairchild	54LS153	
	Raytheon	**54LS153**	**258**
	Signetics	54LS153	
SN54LS155	Fairchild	54LS155	
	Raytheon	**54LS155**	**260**
SN54LS156	Fairchild	54LS156	
	Raytheon	**54LS156**	**260**
SN54LS157	AMD	SN54LS157	
	Fairchild	54LS157	
	Raytheon	**54LS157**	**262**
	Signetics	54LS157	
SN54LS158	AMD	SN54LS158	
	Fairchild	54LS158	
	Raytheon	**54LS158**	**262**
	Signetics	54LS158	
SN54LS160	AMD	SN54LS160	
	Fairchild	54LS160	
	Raytheon	**54LS160**	**264**
	Signetics	54LS160	
SN54LS161	AMD	SN54LS161	
	Fairchild	54LS161	
	Raytheon	**54LS161**	**264**
	Signetics	54LS161	
SN54LS162	AMD	SN54LS162	
	Fairchild	54LS162	
	Raytheon	**54LS162**	**264**
	Signetics	54LS162	
SN54LS163	AMD	SN54LS163	
	Fairchild	54LS163	
	Raytheon	**54LS163**	**264**
	Signetics	54LS163	
SN54LS164	AMD	SN54LS164	
	Fairchild	54LS164	
	Signetics	54LS164	
SN54LS168	AMD	SN54LS168	
SN54LS169	AMD	SN54LS169	
SN54LS170	AMD	SN54LS170	
	Fairchild	54LS170	
	Signetics	54LS170	
SN54LS174	AMD	SN54LS174	
	Fairchild	54LS174	
	Raytheon	**54LS174**	**275**
	Signetics	54LS174	
SN54LS175	AMD	SN54LS175	
	Fairchild	54LS175	
SN54LS175	**Raytheon**	**54LS175**	**275**
	Signetics	54LS175	
SN54LS181	AMD	SN54LS181	
	Fairchild	54LS181	
	Raytheon	**54LS181**	**277**
SN54LS188	MMI	5330	
SN54LS190	AMD	SN54LS190	
	Fairchild	54LS190	
	Raytheon	**54LS190**	**283**
	Signetics	54LS190	
SN54LS191	AMD	SN54LS191	
	Fairchild	54LS191	
	Raytheon	**54LS191**	**283**
	Signetics	54LS191	
SN54LS192	AMD	SN54LS192	
	Fairchild	54LS192	
	Raytheon	**54LS192**	**291**
	Signetics	54LS192	
SN54LS193	AMD	SN54LS193	
	Fairchild	54LS193	
	Raytheon	**54LS193**	**291**
	Signetics	54LS193	
SN54LS194A	AMD	SN54LS194A	
	Fairchild	54LS194	
	Raytheon	**54LS194A**	**299**
	Signetics	54LS194A	
SN54LS195A	AMD	SN54LS195A	
	Fairchild	54LS195	
	Raytheon	**54LS195A**	**302**
	Signetics	54LS195A	
SN54LS196	Fairchild	54LS196	
	Raytheon	**54LS196**	**305**
	Signetics	54LS196	
SN54LS197	Fairchild	54LS197	
	Raytheon	**54LS197**	**305**
	Signetics	54LS197	
SN54LS20	Fairchild	54LS20	
	National	DM54LS20	
	Raytheon	**54LS20**	**210**
	Signetics	54LS20	
SN54LS21	Fairchild	54LS21	
	Raytheon	**54LS21**	**215**
	Signetics	54LS21	
SN54LS22	Fairchild	54LS22	
	National	DM54LS22	
	Raytheon	**54LS22**	**212**
	Signetics	54LS22	
SN54LS221	Signetics	54LS221	
SN54LS229	Raytheon	54LS229	
SN54LS240	AMD	SN54LS240	
SN54LS241	AMD	SN54LS241	
SN54LS251	AMD	SN54LS251	
	Fairchild	54LS251	
	Raytheon	**54LS251**	**309**
	Signetics	54LS251	
SN54LS253	AMD	SN54LS253	
	Fairchild	54LS253	
	Raytheon	**54LS253**	**312**
	Signetics	54LS253	
SN54LS257	AMD	SN54LS257	
	Fairchild	54LS257	
	Raytheon	**54LS257**	**315**
	Signetics	54LS257	
SN54LS258	AMD	SN54LS258	
	Fairchild	54LS258	
	Raytheon	**54LS258**	**315**
	Signetics	54LS258	
SN54LS259	Fairchild	54LS259	
SN54LS26	Fairchild	54LS26	
	Raytheon	**54LS26**	**222**
	Signetics	54LS26	
SN54LS261	Signetics	54LS261	
SN54LS266	Fairchild	54LS266	
	Raytheon	**54LS266**	**253**
	Signetics	54LS266	
SN54LS27	Fairchild	54LS27	
	Raytheon	**54LS27**	**214**
	Signetics	54LS27	
SN54LS273	AMD	SN54LS273	
SN54LS279	Fairchild	54LS279	
SN54LS28	**Raytheon**	**54LS28**	**223**
SN54LS28	Signetics	54LS28	
SN54LS281	AMD	SN54LS281	
		SN54LS281	
SN54LS283	Fairchild	54LS283	
	Raytheon	54LS283	
	Signetics	54LS283	
SN54LS290	Fairchild	54LS290	
	Signetics	54LS290	
SN54LS293	Fairchild	54LS293	
	Signetics	54LS293	
SN54LS295A	Fairchild	54LS295	
	Raytheon	**54LS295A**	**321**
	Signetics	54LS295A	
SN54LS298	Fairchild	54LS298	
	Raytheon	**54LS298**	**323**
SN54LS299	AMD	SN54LS299	
SN54LS30	Fairchild	54LS30	
	National	DM54LS30	
	Raytheon	**54LS30**	**210**
	Signetics	54LS30	
SN54LS32	Fairchild	54LS32	
	Raytheon	**54LS32**	**225**
	Signetics	54LS32	
SN54LS322	AMD	AM25LS22	
		SN54LS322	
SN54LS323	AMD	AM25LS23	
SN54LS33	**Raytheon**	**54LS33**	**226**
	Signetics	54LS33	
SN54LS365	**Raytheon**	**54LS365**	**325**
SN54LS366	**Raytheon**	**54LS366**	**325**
SN54LS367	Raytheon	54LS367	
SN54LS368	Fairchild	54LS368	
	Raytheon	54LS368	
SN54LS37	Fairchild	54LS37	
	Raytheon	**54LS37**	**223**
	Signetics	54LS37	
SN54LS373	AMD	SN54LS373	
SN54LS374	AMD	SN54LS374	
SN54LS375	Raytheon	54LS375	
SN54LS377	AMD	SN54LS377	
SN54LS378	AMD	SN54LS378	
		SN54LS378	
SN54LS379	AMD	AM25LS08	
		SN54LS379	
SN54LS38	Fairchild	54LS38	
	Raytheon	**54LS38**	**226**
	Signetics	54LS38	
SN54LS381	AMD	SN54LS381	
SN54LS384	AMD	AM25LS14	
		SN54LS384	
SN54LS385	AMD	AM25LS15	
		SN54LS385	
SN54LS386	**Raytheon**	**54LS386**	**242**
	Signetics	54LS386	
SN54LS388	AMD	AM25LS2518	
SN54LS395	**Raytheon**	**54LS395**	**327**
SN54LS399	AMD	AM25LS09	
		SN54LS399	
SN54LS40	Fairchild	54LS40	
	Raytheon	**54LS40**	**223**
	Signetics	54LS40	
SN54LS42	Fairchild	54LS42	
	Signetics	54LS42	
SN54LS424	AMD	SN54LS424	
SN54LS51	Fairchild	54LS51	
	Raytheon	**54LS51**	**230**
	Signetics	54LS51	
SN54LS54	Fairchild	54LS54	
	Raytheon	**54LS54**	**230**
	Signetics	54LS54	
SN54LS55	Fairchild	54LS55	
	Raytheon	**54LS55**	**230**
	Signetics	54LS55	
SN54LS670	AMD	SN54LS670	
	Fairchild	54LS670	
	Raytheon	54LS670	
	Signetics	54LS670	
SN54LS73	Fairchild	54LS73	
	Raytheon	**54LS73**	**232**
	Signetics	54LS73	
SN54LS74	Fairchild	54LS74	
SN54LS74	National	DM54LS74	
	Raytheon	**54LS74**	**235**
	Signetics	54LS74	
SN54LS75	Signetics	54LS75	
SN54LS76	**Raytheon**	**54LS76**	**232**
	Signetics	54LS76	
SN54LS78	**Raytheon**	**54LS78**	**237**
	Signetics	54LS78	
SN54LS83A	Fairchild	54LS83	
	Raytheon	**54LS83A**	**239**
	Signetics	54LS83A	
SN54LS85	Signetics	54LS85	
SN54LS86	Fairchild	54LS86	
	Raytheon	**54LS86**	**242**
	Signetics	54LS86	
SN54LS90	Fairchild	54LS90	
	Signetics	54LS90	
SN54LS92	Fairchild	54LS92	
	Raytheon	**54LS92**	**243**
	Signetics	S54LS92	
SN54LS93	**Raytheon**	**54LS93**	**243**
SN54LS95B	Fairchild	54LS95	
	Signetics	54LS95B	
SN54LS96	Signetics	54LS96	
SN54L00	National	DM54L00	
SN54L01	National	DM54L01	
SN54L02	National	DM54L02	
SN54L03	National	DM54L03	
SN54L04	National	DM54L04	
SN54L10	National	DM54L10	
♦SN54L123	National	DM54L123	
SN54L154	National	DM54L154A	
SN54L157	National	DM54L157A	
SN54L164	National	DM54L164	
SN54L192	National	DM54L192	
SN54L193	National	DM54L193	
SN54L20	National	DM54L20	
SN54L30	National	DM54L30	
SN54L42A	National	DM54L42A	
SN54L51	National	DM54L51	
SN54L54	National	DM54L54	
SN54L55	National	DM54L55	
SN54L71	National	DM54L71	
SN54L73	National	DM54L73	
SN54L74	National	DM54L74	
♦SN54L75	National	DM54L75	
SN54L78	National	DM54L78	
SN54L85	National	DM54L85	
SN54L86	National	DM54L86	
SN54L90	National	DM54L90	
SN54L91	National	DM54L91	
SN54L93	National	DM54L93	
SN54L95	National	DM54L95	
SN54L98	National	DM54L98	
SN54S00	Fairchild	54S00	
		9S00	
SN54S03	Fairchild	54S03	
		9S03	
SN54S04	Fairchild	54S04	
		9S04	
SN54S05	Fairchild	54S05	
		9S05	
SN54S112	Fairchild	54S112	
		9S112	
SN54S113	Fairchild	54S113	
		9S113	
SN54S114	Fairchild	54S114	
		9S114	
SN54S133	Fairchild	9S133	
SN54S134	Fairchild	9S134	
SN54S138	AMD	SN54S138	
SN54S139	AMD	SN54S139	
SN54S140	Fairchild	54S140	
		9S140	
	National	DM54S140	
SN54S151	AMD	SN54S151	
SN54S153	AMD	SN54S153	
SN54S157	AMD	SN54S157	
SN54S158	AMD	SN54S158	
SN54S174	AMD	SN54S174	
SN54S175	AMD	SN54S175	

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Bold face device numbers indicate manufacturers' data is provided in the IC Master on the pages noted.

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Manufacturer Device	Replacement Source	Device	IC Master Page
SN54S181	AMD	SN54S181	
	Fairchild	54S181	
		93S41	
SN54S182	Fairchild	54S182	
		93S42	
SN54S188	AMD	AM27S09	
	Harris	**HM7602**	**682**
SN54S188A	MMI	5330	
SN54S189	AMD	AM27S03	
		SN54S189	
	National	**DM54S189**	**746**
SN54S194	AMD	SN54S194	
SN54S195	AMD	SN54S195	
	Fairchild	93S00	
SN54S20	Fairchild	54S20	
		9S20	
♦SN54S200	Intersil	IM5523	
	MMI	5531	
	National	**DM54S200**	**704**
	Raytheon	RM5340	
	Signetics	54S200	
	TI	SN54S201	
SN54S201	**National**	**DM54S200**	**704**
SN54S206	Fairchild	93411	
	Intersil	IM5533	
	MMI	5205	
	National	**DM54S206**	**751**
	Raytheon	RM5330	
	TI	SN74S301	
SN54S22	Fairchild	54S22	
		9S22	
SN54S251	AMD	SN54S251	
SN54S257	AMD	SN54S257	
SN54S258	AMD	SN54S258	
SN54S270	MMI	5205	
SN54S287	**Harris**	**HM7611**	**682**
	MMI	5301	
SN54S288	**Harris**	**HM7603**	**682**
	MMI	5331	
	National	**DM7578**	**702**
SN54S289	AMD	AM27S02	
		SN54S289	
	National	DM54S289	
SN54S301	**National**	**DM54S206**	**751**
SN54S370	MMI	5206	
SN54S387	**Harris**	**HM7610**	**682**
	Intel	M3601	
		3601	**695**
	MMI	5300	
		6300	
	National	**DM54S387**	**708**
	Signetics	S82S126	
SN54S40	Fairchild	54S40	
		9S40	
SN54S412	AMD	SN54S412	
SN54S64	Fairchild	54S64	
		9S64	
SN54S65	Fairchild	54S65	
		9S65	
SN54S74	Fairchild	54S74	
		9S74	
SN5400	Fairchild	5400	
		9N00	
	National	DM5400	
	Raytheon	5400	
	Signetics	5400	
SN5401	Fairchild	5401	
		9N01	
	National	DM5401	
	Raytheon	5401	
	Signetics	5401	
SN5402	Fairchild	5402	
		9N02	
	National	DM5402	
	Signetics	5402	
SN5403	Fairchild	5403	
		9N03	
	National	DM5403	
SN5403	Raytheon	5403	
	Signetics	5403	
SN5404	Fairchild	5404	
		9N04	
	National	DM5404	
	Raytheon	5404	
	Signetics	5404	
SN5405	Fairchild	5405	
		9N05	
	National	DM5405	
	Raytheon	5405	
	Signetics	5405	
SN5406	Fairchild	5406	
		9N06	
	National	DM5406	
	Signetics	5406	
SN5407	Fairchild	5407	
		9N07	
	National	DM5407	
	Signetics	5407	
SN5408	Fairchild	5408	
		9N08	
	National	DM5408	
	Raytheon	5408	
	Signetics	5408	
SN5409	Fairchild	5409	
		9N09	
	National	DM5409	
	Raytheon	5409	
	Signetics	5409	
SN5410	Fairchild	5410	
		9N10	
	National	DM5410	
	Raytheon	5410	
	Signetics	5410	
SN54107	AMD	SN54107	
	Fairchild	54107	
		9N107	
	National	DM54107	
	Signetics	54107	
SN54109	National	DM54109	
	Signetics	54109	
SN5412	Fairchild	5412	
		9N12	
	Raytheon	5412	
SN54121	Fairchild	54121	
		9603	
	Motorola	MC9603	
	National	DM54121	
	Signetics	54121	
SN54123	AMD	AM26123	
		SN54123	
	National	DM54123	
	Raytheon	54123	
	Signetics	54123	
SN54125	National	DM7093	
SN54126	National	DM7094	
SN5413	Fairchild	5413	
		9N13	
	National	DM5413	
	Signetics	5413	
SN54132	National	DM54132	
	Signetics	54132	
SN54136	Raytheon	54136	
SN5414	National	DM5414	
	Signetics	5414	
SN54141	National	DM54141	
	Signetics	54141	
SN54145	Fairchild	54145	
		93145	
	National	DM54145	
	Raytheon	54145	
	Signetics	54145	
SN54150	Fairchild	54150	
		93150	
	National	DM54150	
	Raytheon	54150	
	Signetics	54150	
♦SN54151	Fairchild	54151	
		93151	
	National	DM54151	
SN54151	Raytheon	54151	
	Signetics	54151	
	TI	SN54151A	
♦SN54152	Fairchild	54152	
		93152	
	Raytheon	54152	
	Signetics	54152	
	TI	SN54152A	
SN54153	AMD	SN54153	
	Fairchild	54153	
		93153	
	National	DM54153	
	Raytheon	54153	
	Signetics	54153	
SN54154	AMD	SN54154	
	Fairchild	9311	
	National	DM54154	
	Raytheon	54154	
	Signetics	54154	
SN54155	Fairchild	93155	
	National	DM54155	
	Raytheon	54155	
	Signetics	54155	
SN54156	Fairchild	93156	
	National	DM54156	
	Raytheon	54156	
	Signetics	54156	
SN54157	AMD	SN54157	
	Fairchild	9322	
	National	DM9322	
	Raytheon	54157	
	Signetics	54157	
SN54159	Raytheon	54159	
SN5416	Fairchild	5416	
		9N16	
	National	DM5416	
	Signetics	5416	
SN54160	AMD	SN54160	
	Fairchild	9310	
	National	DM54160	
	Raytheon	54160	
	Signetics	54160	
SN54161	AMD	SN54161	
	Fairchild	9316	
	National	DM54161	
	Raytheon	54161	
	Signetics	54161	
SN54162	AMD	SN54162	
	National	DM54162	
	Raytheon	54162	
	Signetics	54162	
SN54163	AMD	SN54163	
	National	DM54163	
	Raytheon	54163	
	Signetics	54163	
SN54164	AMD	SN54164	
	Fairchild	54164	
		93164	
	National	DM7570	
	Raytheon	54164	
	Signetics	54164	
SN54165	Fairchild	54165	
		93165	
	National	DM7590	
	Raytheon	54165	
	Signetics	54165	
SN54166	Fairchild	54166	
		93166	
	National	DM54166	
	Raytheon	54166	
	Signetics	54166	
SN5417	Fairchild	5417	
		9N17	
	National	DM5417	
	Signetics	5417	
SN54170	Fairchild	54170	
	Raytheon	54170	
SN54173	National	DM7551	
SN54174	AMD	SN54174	
	Fairchild	93174	
	National	DM54174	
SN54174	Raytheon	54174	
	Signetics	54174	
SN54175	AMD	SN54175	
	Fairchild	93175	
	National	DM54175	
	Raytheon	54175	
	Signetics	54175	
SN54176	Fairchild	54176	
		93176	
	National	DM7280	
	Signetics	S8280	
SN54177	Fairchild	54177	
		93177	
	National	DM7281	
	Signetics	S8281	
SN54178	Fairchild	54178	
		93178	
	Signetics	S8270	
SN54179	Fairchild	54179	
		93179	
SN54180	Fairchild	54180	
		93180	
	National	DM54180	
	Raytheon	54180	
	Signetics	54180	
SN54181	AMD	SN54181	
		9341	
	Fairchild	54181	
		9341	
	National	DM54181	
	Raytheon	54181	
	Signetics	54181	
SN54182	AMD	SN54182	
		9342	
	Fairchild	54182	
		9342	
	National	DM54182	
	Raytheon	54182	
	Signetics	54182	
SN54184	National	DM54184	
SN54185A	National	DM54185A	
SN54186	Harris	HPROM0512	
SN54187	Intersil	IM5603	
	MMI	5200	
SN54188	**Harris**	**HM7602**	**682**
SN54188A	MMI	5330	
	National	**DM7577**	**702**
SN54190	Fairchild	54190	
		93190	
	National	DM54190	
	Raytheon	54190	
SN54191	Fairchild	54191	
		93191	
	National	DM54191	
	Raytheon	54191	
SN54192	AMD	SN54192	
		9360	
	Fairchild	54192	
		9360	
	National	DM7560	
	Raytheon	54192	
	Signetics	54192	
SN54193	AMD	SN54193	
		9366	
	Fairchild	54193	
		9366	
	National	DM7563	
	Raytheon	54193	
	Signetics	54193	
SN54194	AMD	SN54194	
	National	DM54194	
	Raytheon	54194	
SN54195	AMD	SN54195	
	Fairchild	9300	
	National	DM9300	
	Raytheon	54195	
	Signetics	54195	
SN54196	Fairchild	54196	
		93196	
	National	DM54196	
	Signetics	S8290	

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The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

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Manufacturer Device	Replacement Source	Device	IC Master Page
SN54197	Fairchild	54197	
		93197	
	National	DM54197	
SN54198	Fairchild	54198	
		93198	
	National	DM54198	
	Raytheon	54198	
	Signetics	54198	
SN54199	National	DM54199	
	Raytheon	54199	
	Signetics	54199	
SN5420	Fairchild	5420	
		9N20	
	National	DM5420	
	Raytheon	5420	
	Signetics	S8819	
		5420	
♦SN54200	MMI	5531	
	TI	SN54S201	
SN54206	MMI	5530	
	National	**DM54S206**	**751**
	TI	SN54S301	
SN5422	Raytheon	5422	
SN54221	AMD	SN54221	
SN5423	Fairchild	5423	
		9N23	
	National	DM5423	
SN5425	Fairchild	5425	
		9N25	
	National	DM5425	
SN54251	National	DM7121	
SN5426	Fairchild	5426	
		9N26	
	National	DM5426	
	Signetics	S8T18	
		5426	
SN5427	Fairchild	5427	
		9N27	
	National	DM5427	
	SW	SW5427	
SN54270	MMI	5205	
SN54278	Motorola	MC54278	
SN54279	Motorola	MC54279	
SN54280	Raytheon	54280	
SN54283	Raytheon	54283	
SN54284	National	DM7875A	
SN54285	National	DM7875B	
SN5430	Fairchild	5430	
		9N30	
	National	DM5430	
	Signetics	S8808	
		5430	
SN5432	Fairchild	5432	
		9N32	
	National	DM5432	
	Signetics	5432	
	SW	SW5432	
SN54365	National	DM7095	
SN54366	National	DM7096	
SN54367	National	DM7097	
SN54368	National	DM7098	
SN5437	Fairchild	5437	
		9N37	
	National	DM5437	
	Signetics	5437	
SN54370	MMI	5206	
SN5438	Fairchild	5438	
		9N38	
	National	DM5438	
	Signetics	5438	
SN5440	Fairchild	5440	
		9N40	
	National	DM5440	
	Signetics	5440	
♦SN5442	Fairchild	5442	
		9352	
	National	DM5442	
	Raytheon	5442	
SN5442	Signetics	5442	
	TI	SN5442A	
SN54425	National	DM7093	
SN54426	National	DM7094	
♦SN5443	Fairchild	5443	
		9353	
	Raytheon	5443	
	Signetics	5443	
	TI	SN5443A	
♦SN5444	Fairchild	5444	
		9354	
	Raytheon	5444	
	Signetics	5444	
	TI	SN5444A	
SN5445	Fairchild	5445	
		9345	
	National	DM5445	
	Raytheon	5445	
	Signetics	5445	
♦SN5446	Fairchild	5446	
		9357	
	National	DM5446	
	TI	SN5446A	
♦SN5447	Fairchild	5447	
		9357	
	National	DM5447	
	TI	SN5447A	
SN5448	Fairchild	5448	
		9358	
	National	DM5448	
	Signetics	5448	
SN5449	Fairchild	5449	
		9359	
SN5450	Fairchild	5450	
		9N50	
	National	DM5450	
	Signetics	5450	
SN5451	Fairchild	5451	
		9N91	
	National	DM5451	
	Signetics	5451	
SN5453	Fairchild	5453	
		9N53	
	National	DM5453	
	Signetics	5453	
SN5454	Fairchild	5454	
		9N54	
	National	DM5454	
	Signetics	5454	
SN5460	Fairchild	5460	
		9N60	
	National	DM5460	
	Signetics	5460	
SN5470	Fairchild	5470	
		9N70	
	National	DM5470	
	Signetics	5470	
SN5472	Fairchild	9N72	
	National	DM5472	
	Signetics	5472	
SN5473	Fairchild	5473	
		9N73	
	National	DM5473	
	Signetics	5473	
SN5474	Fairchild	5474	
		9N74	
	National	DM5474	
	Raytheon	5474	
	Signetics	5474	
SN5475	Fairchild	5475	
		9375	
	National	DM5475	
	Signetics	5475	
SN5476	Fairchild	5476	
		9N76	
	Motorola	MC5476	
	National	DM5476	
	Signetics	5476	
SN5477	Fairchild	5477	
		9377	
	Signetics	5477	
SN5480	Fairchild	5480	
		9380	
	Signetics	5480	
♦SN5481	Fairchild	93407	
	Raytheon	5481	
	TI	SN5481A	
SN5482	Fairchild	5482	
		9382	
♦SN5483	Fairchild	5483	
		9383	
	National	DM5483	
	Raytheon	5483	
	Signetics	5483	
	TI	SN5483A	
SN5485	National	DM5485	
SN5486	Fairchild	5486	
		9N86	
	National	DM5486	
	Raytheon	5486	
	Signetics	5486	
♦SN5488	Intersil	IM5600	
	MMI	5230	
	National	**DM5488**	**702**
	TI	SN5488A	
♦SN5489	AMD	SN5489	
	Fairchild	93403	
	MMI	5560	
	National	**DM5489**	**704**
		DM5489	**741**
	Raytheon	5489	
	Signetics	S8225	
	TI	SN54S189	
♦SN5490	Fairchild	5490	
		9390	
	National	DM5490	
	Signetics	5490	
	TI	SN5490A	
♦SN5491	Fairchild	5491	
		9391	
	National	DM5491	
	Signetics	5491	
	TI	SN5491A	
♦SN5492	Fairchild	5492	
		9392	
	National	DM5492	
	Signetics	5492	
	TI	SN5492A	
♦SN5493	Fairchild	5493	
		9393	
	National	DM5493	
	Signetics	5493	
	TI	SN5493A	
SN5494	Fairchild	5494	
		9394	
	Signetics	5494	
♦SN5495	Fairchild	5495	
		9395	
	National	DM5495	
	Signetics	5495	
	TI	SN5495A	
SN5496	Fairchild	5496	
		9396	
	National	DM5496	
	Signetics	5496	
SN5510	Motorola	MC1510	
SN55107	AMD	SN55107	
	Fairchild	55107	
	Motorola	MC55107	
	National	**DS55107**	**475**
	Raytheon	RM55107	
	Silicon G	SG107	
SN55108	AMD	SN55108B	
	Fairchild	55108	
	Motorola	MC55108	
	National	**DS55108**	**475**
	Raytheon	RM55108	
	Silicon G	SG108	
SN55109	AMD	SN55109	
	Fairchild	55109	
	Raytheon	RM55109	
	Silicon G	SG109	
SN55110	AMD	SN55110	
	Fairchild	55110	
	Raytheon	RM55110	
	Silicon G	SG110	
SN55112	Fairchild	55112	
SN55114	Fairchild	96114	
	ITT	ITT9614	
SN55115	Fairchild	96115	
	ITT	ITT9615	
SN55121	Fairchild	55121	
	National	DS55121	
SN55122	Fairchild	55122	
	National	DS55122	
SN55123	Fairchild	55123	
	Silicon G	SG123	
SN55124	Fairchild	55124	
	Silicon G	SG124	
SN55138	Silicon G	SG55138	
SN55180	National	DS7800	
SN55182	National	DS7820	
	Signetics	DM7820	
SN55183	National	DS7830	
	Signetics	DM7830	
SN5520	National	DS5520	
	Silicon G	SG5520	
SN55207	Fairchild	55207	
	Silicon G	SG207	
SN55208	Fairchild	55208	
	Silicon G	SG208	
SN5521	National	DS5521	
	Silicon G	SG5521	
SN5522	Motorola	MC5522	
	National	DS5522	
	Silicon G	SG5522	
SN55224	Fairchild	55224	
SN55225	Fairchild	55225	
SN5523	Motorola	MC5523	
	National	DS5523	
	Silicon G	SG5523	
SN55232	Fairchild	55232	
SN55233	Fairchild	55233	
SN55234	AMD	SN55234	
	Fairchild	55234	
SN55235	Fairchild	55235	
SN55238	AMD	SN55238	
	Fairchild	55238	
SN55239	AMD	SN55239	
	Fairchild	55239	
	Silicon G	SG239	
SN5524	Fairchild	5524	
	Motorola	MC5524	
	National	DS5524	
	Silicon G	SG5524	
SN55244	AMD	MC1544	
		MC1544	
SN5525	Fairchild	5525	
	Motorola	MC5525	
	National	DS5525	
	Silicon G	SG5525	
SN5528	Fairchild	5528	
	Motorola	MC5528	
	National	DS5528	
	Silicon G	SG5528	
SN5529	Fairchild	5529	
	Motorola	MC5529	
	National	DS5529	
	Silicon G	SG5529	
SN55325	AMD	SN55325	
	Fairchild	55325	
	Motorola	MC55325	
	National	**DS55325**	**495**
	Raytheon	RM55325	
	Silicon G	SG55325	
SN55326	Fairchild	55326	
SN55327	Fairchild	55327	
SN5534	Fairchild	5534	
	National	DS5534	
	Silicon G	SG5534	
SN5535	Fairchild	5535	
	National	DS5535	
	Silicon G	SG5535	

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Manufacturer Device	Replacement Source	Device	IC Master Page
SN55361	National	DS55361	
SN55365	National	DS55365	
SN55369	**National**	**DS0026**	**474**
SN5538	Fairchild	5538	
	National	DS5538	
	Silicon G	SG5538	
SN5539	Fairchild	5539	
	National	DS5539	
	Silicon G	SG5539	
SN55450	Fairchild	55450	
	National	DS55450	
	Raytheon	RM55450	
	Silicon G	SG55450	
SN55451	Fairchild	55451	
	National	DS55451	
	Raytheon	RM55451	
	Silicon G	SG55451	
SN55452	Fairchild	55452	
	National	DS55452	
	Raytheon	RM55452	
	Silicon G	SG55452	
SN55453	Fairchild	55453	
	National	DS55453	
	Raytheon	RM55453	
	Silicon G	SG55453	
SN55454	Fairchild	55454	
	National	DS55454	
	Raytheon	RM55454	
	Silicon G	SG55454	
SN55460	Fairchild	55460	
	National	DS55460	
	Silicon G	SG55460	
SN55461	Fairchild	55461	
	National	DS55461	
	Silicon G	SG55461	
SN55462	Fairchild	55462	
	National	DS55462	
	Silicon G	SG55462	
SN55463	Fairchild	55463	
	National	DS55463	
	Silicon G	SG55463	
SN55464	Fairchild	55464	
	National	DS55464	
	Silicon G	SG55464	
SN55470	Fairchild	55470	
SN55471	Fairchild	55471	
SN55472	Fairchild	55472	
SN55473	Fairchild	55473	
SN55474	Fairchild	55474	
SN55480	National	DS7880	
SN55493	National	DS55493	
SN55494	National	DS55494	
♦SN56502	TI	TL441	
♦SN72L022	TI	TL022	
♦SN72L044	TI	TL044	
♦SN72301A	TI	LM301	
♦SN72304	TI	LM304	
♦SN72305	TI	LM305	
♦SN72306	TI	LM306	
♦SN72307	TI	LM307	
♦SN72308	AMD	LM308	
	Fairchild	μA308	
	Intersil	LM308	
	Motorola	MLM308	
	Raytheon	LM308	
	RCA	CA308	
	Silicon G	SG308	
	Teledyne S	LM308	
♦SN72309	TI	LM309	
♦SN72310	AMD	LM310	
	Fairchild	μA310	
	Intersil	LM310	
	Motorola	MLM310	
	Silicon G	SG310	
♦SN72311	TI	LM311	
♦SN72318	TI	LM318	
♦SN72376	TI	LM376	
♦SN72440	TI	TL440	
♦SN72506	TI	TL506	
♦SN72510	TI	TL510	
♦SN72514	TI	TL514	
♦SN72555	TI	NE555	
♦SN72558	TI	MC1458	
♦SN72560	TI	TL560	
♦SN72702	TI	TL702	
♦SN72709	TI	μA709	
♦SN72710	TI	TL710	
♦SN72711	TI	μA711	
♦SN72720	TI	TL720	
♦SN72723	TI	μA723	
♦SN72733	TI	μA733	
♦SN72741	TI	μA741	
♦SN72747	TI	μA747	
♦SN72748	TI	μA748	
♦SN72777	TI	μA777	
♦SN72810	TI	TL810	
♦SN72811	TI	TL811	
♦SN72820	TI	TL820	
♦SN72905	Motorola	MC7905	
♦SN72906	Motorola	MC7906	
♦SN72912	Motorola	MC7912	
♦SN72915	Motorola	MC7915	
SN74H00	Fairchild	74H00	
		9H00	
	ITT	ITT74H00	
	Motorola	MC74H00	
	National	DM74H00	
	Raytheon	74H00	
	Signetics	74H00	
SN74H01	Fairchild	74H01	
		9H01	
	ITT	ITT74H01	
	Motorola	MC74H01	
	National	DM74H01	
	Raytheon	74H01	
	Signetics	74H01	
SN74H04	Fairchild	74H04	
		9H04	
	ITT	ITT74H04	
	Motorola	MC74H04	
	National	DM74H04	
	Raytheon	74H04	
	Signetics	74H04	
SN74H05	Fairchild	74H05	
		9H05	
	ITT	ITT74H05	
	Motorola	MC74H05	
	National	DM74H05	
	Raytheon	74H05	
	Signetics	74H05	
SN74H10	Fairchild	74H10	
		9H10	
	ITT	ITT74H10	
	Motorola	MC74H10	
	National	DM74H10	
	Raytheon	74H10	
	Signetics	74H10	
SN74H101	Motorola	MC74H101	
	Signetics	74H101	
SN74H102	Motorola	MC74H102	
	Signetics	74H102	
SN74H103	National	DM74H103	
	Signetics	74H103	
SN74H106	Fairchild	74H106	
		9H106	
	National	DM74H106	
	Signetics	74H106	
SN74H108	Fairchild	74H108	
		9H108	
	Motorola	MC74H108	
	National	DM74H108	
	Signetics	74H108	
SN74H11	Fairchild	74H11	
		9H11	
	ITT	ITT74H11	
	Motorola	MC74H11	
	National	DM74H11	
	Raytheon	74H11	
	Signetics	74H11	
SN74H183	Fairchild	74H183	
		93H183	
	Hitachi	HD2563	
SN74H20	Fairchild	74H20	
		9H20	
	ITT	ITT74H20	
	Motorola	MC74H20	
	National	DM74H20	
	Raytheon	74H20	
	Signetics	74H20	
SN74H21	Fairchild	74H21	
		9H21	
	ITT	ITT74H21	
	Motorola	MC74H21	
	National	DM74H21	
	Signetics	74H21	
SN74H22	Fairchild	74H22	
		9H22	
	Motorola	MC74H22	
	National	DM74H22	
	Raytheon	74H22	
	Signetics	74H22	
SN74H30	Fairchild	74H30	
		9H30	
	ITT	ITT74H30	
	Motorola	MC74H30	
	National	DM74H30	
	Signetics	74H30	
SN74H40	Fairchild	74H40	
		9H40	
	ITT	ITT74H40	
	Motorola	MC74H40	
	National	DM74H40	
	Raytheon	74H40	
	Signetics	74H40	
SN74H50	Fairchild	74H50	
		9H50	
	ITT	ITT74H50	
	Motorola	MC74H50	
	National	DM74H50	
	Signetics	74H50	
SN74H51	Fairchild	74H51	
		9H51	
	ITT	ITT74H51	
	Motorola	MC74H51	
	National	DM74H51	
	Signetics	74H51	
SN74H52	Fairchild	74H52	
		9H52	
	Motorola	MC74H52	
	National	DM74H52	
	Signetics	74H52	
SN74H53	Fairchild	74H53	
		9H53	
	ITT	ITT74H53	
	Motorola	MC74H53	
	National	DM74H53	
	Signetics	74H53	
SN74H54	Fairchild	74H54	
		9H54	
	ITT	ITT74H54	
	Motorola	MC74H54	
	National	DM74H54	
	Signetics	74H54	
SN74H55	Fairchild	74H55	
		9H55	
	Motorola	MC74H55	
	National	DM74H55	
	Signetics	74H55	
SN74H60	Fairchild	74H60	
		9H60	
	ITT	ITT74H60	
	Motorola	MC74H60	
	National	DM74H60	
	Signetics	74H60	
SN74H61	Fairchild	74H61	
		9H61	
	Motorola	MC74H61	
	National	DM74H61	
	Signetics	74H61	
SN74H62	Fairchild	74H62	
	Motorola	MC74H62	
	National	DM74H62	
	Signetics	74H62	
SN74H71	Fairchild	74H71	
		9H71	
	Motorola	MC74H71	
	National	DM74H71	
	Signetics	74H71	
SN74H72	Fairchild	74H72	
		9H72	
	ITT	ITT74H72	
	Motorola	MC74H72	
	National	DM74H72	
	Signetics	74H72	
SN74H73	Fairchild	74H73	
		9H73	
	ITT	ITT74H73	
	Motorola	MC74H73	
	National	DM74H73	
	Signetics	74H73	
SN74H74	Fairchild	74H74	
		9H74	
	ITT	ITT74H74	
	Motorola	MC74H74	
	National	DM74H74	
	Raytheon	74H74	
	Signetics	74H74	
SN74H76	Fairchild	74H76	
		9H76	
	ITT	ITT74H76	
	Motorola	MC74H76	
	National	DM74H76	
	Signetics	74H76	
SN74H78	Fairchild	74H78	
		9H78	
	National	DM74H78	
SN74H87	Fairchild	74H87	
		93H87	
	Motorola	MC74H87	
SN74LS00	Fairchild	74LS00	
	National	DM74LS00	
	Raytheon	**74LS00**	**210**
	Signetics	74LS00	
SN74LS01	National	DM74LS01	
	Raytheon	**74LS01**	**212**
	Signetics	74LS01	
SN74LS02	Fairchild	74LS02	
	Raytheon	**74LS02**	**214**
	Signetics	74LS02	
SN74LS03	Fairchild	74LS03	
	National	DM74LS03	
	Raytheon	**74LS03**	**212**
	Signetics	74LS03	
SN74LS04	Fairchild	74LS04	
	National	DM74LS04	
	Raytheon	**74LS04**	**210**
	Signetics	74LS04	
SN74LS05	Fairchild	74LS05	
	Raytheon	**74LS05**	**212**
	Signetics	74LS05	
SN74LS08	Fairchild	74LS08	
	Raytheon	**74LS08**	**215**
	Signetics	74LS08	
SN74LS09	Fairchild	74LS09	
	Raytheon	**74LS09**	**217**
	Signetics	74LS09	
SN74LS10	Fairchild	74LS10	
	National	DM74LS10	
	Raytheon	**74LS10**	**210**
	Signetics	74LS10	
SN74LS107	**Raytheon**	**74LS107**	**232**
	Signetics	74LS107	
SN74LS109	Fairchild	74LS109	
	Raytheon	**74LS109**	**251**
	Signetics	74LS109	
SN74LS11	Fairchild	74LS11	
	Raytheon	**74LS11**	**215**
	Signetics	74LS11	
SN74LS112	Fairchild	74LS112	
	Raytheon	**74LS112**	**232**

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The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

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Manufacturer Device	Replacement Source	Device	IC Master Page
SN74LS112	Signetics	74LS112	
SN74LS113	Fairchild	74LS113	
	Raytheon	**74LS113**	**232**
	Signetics	74LS113	
SN74LS114	Fairchild	74LS114	
	Raytheon	**74LS114**	**237**
	Signetics	74LS114	
SN74LS12	National	DM74LS12	
	Raytheon	**74LS12**	**212**
	Signetics	74LS12	
SN74LS122	Raytheon	74LS122	
SN74LS123	AMD	SN74LS123	
	Raytheon	74LS123	
SN74LS125	Fairchild	74LS125	
SN74LS126	Fairchild	74LS126	
SN74LS13	Signetics	74LS13	
SN74LS132	Fairchild	74LS132	
	Signetics	74LS132	
SN74LS136	Fairchild	74LS136	
	Raytheon	**74LS136**	**253**
	Signetics	74LS136	
SN74LS138	AMD	SN74LS138	
	Fairchild	74LS138	
	Raytheon	**74LS138**	**254**
	Signetics	74LS138	
SN74LS139	AMD	SN74LS139	
		SN74LS139	
	Fairchild	74LS139	
	Raytheon	**74LS139**	**254**
	Signetics	74LS139	
SN74LS14	Fairchild	74LS14	
	Raytheon	**74LS14**	**218**
	Signetics	74LS14	
SN74LS145	Signetics	74LS145	
SN74LS148	AMD	SN74LS148	
SN74LS15	Fairchild	74LS15	
	Raytheon	**74LS15**	**217**
	Signetics	74LS15	
SN74LS151	AMD	SN74LS151	
	Fairchild	74LS151	
	Raytheon	**74LS151**	**256**
	Signetics	74LS151	
SN74LS152	Fairchild	74LS152	
	Raytheon	**74LS152**	**256**
SN74LS153	AMD	SN74LS153	
	Fairchild	74LS153	
	Raytheon	**74LS153**	**258**
	Signetics	74LS153	
SN74LS155	Fairchild	74LS155	
	Raytheon	**74LS155**	**260**
SN74LS156	Fairchild	74LS156	
	Raytheon	**74LS156**	**260**
SN74LS157	AMD	SN74LS157	
	Fairchild	74LS157	
	Raytheon	**74LS157**	**262**
	Signetics	74LS157	
SN74LS158	AMD	SN74LS158	
	Fairchild	74LS158	
	Raytheon	**74LS158**	**262**
	Signetics	74LS158	
SN74LS160	AMD	SN74LS160	
	Fairchild	74LS160	
	Raytheon	**74LS160**	**264**
	Signetics	74LS160	
SN74LS161	AMD	SN74LS161	
	Fairchild	74LS161	
	Raytheon	75LS161	
	Signetics	74LS161	
SN74LS162	AMD	SN74LS162	
	Fairchild	74LS162	
	Raytheon	**74LS162**	**264**
	Signetics	74LS162	
SN74LS163	AMD	SN74LS163	
	Fairchild	74LS163	
	Raytheon	**74LS163**	**264**
	Signetics	74LS163	
SN74LS164	AMD	SN74LS164	
	Fairchild	74LS164	
SN74LS164	Signetics	74LS164	
SN74LS168	AMD	SN74LS168	
SN74LS169	AMD	SN74LS169	
SN74LS170	AMD	SN74LS170	
	Fairchild	74LS170	
	Raytheon	74LS170	
	Signetics	74LS170	
SN74LS174	AMD	SN74LS174	
	Fairchild	74LS174	
	Raytheon	**74LS174**	**275**
	Signetics	74LS174	
SN74LS175	AMD	SN74LS175	
	Fairchild	74LS175	
	Raytheon	**74LS175**	**275**
	Signetics	74LS175	
SN74LS181	AMD	SN74LS181	
	Fairchild	74LS181	
	Raytheon	**74LS181**	**277**
	Signetics	74LS181	
SN74LS190	AMD	SN74LS190	
	Fairchild	74LS190	
	Raytheon	**74LS190**	**283**
	Signetics	74LS190	
SN74LS191	AMD	SN74LS191	
	Fairchild	74LS191	
	Raytheon	**74LS191**	**283**
	Signetics	74LS191	
SN74LS192	AMD	SN74LS192	
	Fairchild	74LS192	
	Raytheon	**74LS192**	**291**
	Signetics	74LS192	
SN74LS193	AMD	SN74LS193	
	Fairchild	74LS193	
	Raytheon	**74LS193**	**291**
	Signetics	74LS193	
SN74LS194A	AMD	SN74LS194	
	Fairchild	74LS194	
	Raytheon	**74LS194A**	**299**
	Signetics	74LS194A	
SN74LS195	AMD	SN74LS195	
	Fairchild	74LS195	
	Signetics	74LS195A	
SN74LS195A	**Raytheon**	**74LS195A**	**302**
SN74LS196	Fairchild	74LS196	
	Raytheon	**74LS196**	**305**
	Signetics	74LS196	
SN74LS197	Fairchild	74LS197	
	Raytheon	**74LS197**	**305**
	Signetics	74LS197	
SN74LS20	Fairchild	74LS20	
	National	DM74LS20	
	Raytheon	**74LS20**	**210**
	Signetics	74LS20	
SN74LS21	Fairchild	74LS21	
	Raytheon	**74LS21**	**215**
	Signetics	74LS21	
SN74LS22	Fairchild	74LS22	
	National	DM74LS22	
	Raytheon	**74LS22**	**212**
	Signetics	74LS22	
SN74LS221	Raytheon	74LS221	
	Signetics	74LS221	
SN74LS240	AMD	SN74LS240	
SN74LS241	AMD	SN74LS241	
SN74LS251	AMD	SN74LS251	
	Fairchild	74LS251	
	Raytheon	**74LS251**	**309**
	Signetics	74LS251	
SN74LS253	AMD	SN74LS253	
	Fairchild	74LS253	
	Raytheon	**74LS253**	**312**
	Signetics	74LS253	
SN74LS257	AMD	SN74LS257	
	Fairchild	74LS257	
	Raytheon	**74LS257**	**315**
SN74LS258	AMD	SN74LS258	
	Fairchild	74LS258	
	Signetics	74LS258	
SN74LS259	Fairchild	74LS259	
SN74LS26	Fairchild	74LS26	
	Raytheon	**74LS26**	**222**
SN74LS26	Signetics	74LS26	
SN74LS260	Fairchild	74LS260	
	Signetics	74LS260A	
SN74LS261	Signetics	74LS261	
SN74LS266	Fairchild	74LS266	
	Raytheon	**74LS266**	**253**
	Signetics	74LS266	
SN74LS27	Fairchild	74LS27	
	Raytheon	**74LS27**	**214**
	Signetics	N74LS27	
SN74LS273	AMD	SN74LS273	
SN74LS279	Fairchild	74LS279	
	Raytheon	74LS279	
SN74LS28	**Raytheon**	**74LS28**	**223**
	Signetics	74LS28	
SN74LS281	AMD	SN74LS281	
		SN74LS281	
SN74LS283	Fairchild	74LS283	
	Raytheon	74LS283	
	Signetics	74LS283	
SN74LS290	Fairchild	74LS290	
	Signetics	74LS290	
SN74LS293	Fairchild	74LS293	
	Signetics	74LS293	
SN74LS295A	Fairchild	74LS295	
	Raytheon	**74LS295A**	**321**
	Signetics	74LS295A	
SN74LS298	Fairchild	74LS298	
	Raytheon	**74LS298**	**323**
SN74LS299	AMD	SN74LS299	
SN74LS30	Fairchild	74LS30	
	National	DM74LS30	
	Raytheon	**74LS30**	**210**
	Signetics	74LS30	
SN74LS32	Fairchild	74LS32	
	Raytheon	**74LS32**	**225**
	Signetics	74LS32	
SN74LS322	AMD	AM25LS22	
		SN74LS322	
SN74LS323	AMD	AM25LS23	
		SN74LS323	
SN74LS33	**Raytheon**	**74LS33**	**226**
	Signetics	74LS33	
SN74LS365	**Raytheon**	**74LS365**	**325**
SN74LS366	**Raytheon**	**74LS366**	**325**
SN74LS367	Raytheon	74LS367	
SN74LS368	Fairchild	74LS368	
	Raytheon	74LS368	
	Signetics	74LS368	
SN74LS37	Fairchild	74LS37	
	Raytheon	**74LS37**	**223**
	Signetics	74LS37	
SN74LS373	AMD	SN74LS373	
SN74LS374	AMD	SN74LS374	
SN74LS375	Raytheon	74LS375	
SN74LS377	AMD	SN74LS377	
SN74LS378	AMD	SN74LS378	
SN74LS379	AMD	AM25LS08	
		SN74LS379	
SN74LS38	Fairchild	74LS38	
	Raytheon	**74LS38**	**226**
	Signetics	74LS38	
SN74LS381	AMD	SN74LS381	
SN74LS384	AMD	AM25LS14	
		SN74LS384	
SN74LS385	AMD	AM25LS15	
		SN74LS385	
SN74LS386	**Raytheon**	**74LS386**	**242**
SN74LS388	AMD	AM25LS2518	
SN74LS395	**Raytheon**	**74LS395**	**327**
SN74LS399	AMD	AM25LS09	
		SN74LS399	
SN74LS40	Fairchild	74LS40	
	Raytheon	**74LS40**	**223**
	Signetics	74LS40	
SN74LS42	Fairchild	74LS42	
	Raytheon	**74LS42**	**227**
	Signetics	74LS42	
SN74LS424	AMD	SN74LS424	
SN74LS51	Fairchild	74LS51	
	Raytheon	**74LS51**	**230**
SN74LS51	Signetics	74LS51	
SN74LS54	Fairchild	74LS54	
	Raytheon	**74LS54**	**230**
	Signetics	74LS54	
SN74LS55	Fairchild	74LS55	
		74LS55	
	Raytheon	**74LS55**	**230**
	Signetics	74LS55	
SN74LS670	AMD	SN74LS670	
	Fairchild	74LS670	
	Raytheon	74LS670	
	Signetics	74LS670	
SN74LS73	Fairchild	74LS73	
	Raytheon	**74LS73**	**232**
	Signetics	74LS73	
SN74LS74	Fairchild	74LS74	
	Raytheon	**74LS74**	**235**
	Signetics	74LS74	
SN74LS75	Raytheon	74LS75	
SN74LS76	**Raytheon**	**74LS76**	**232**
	Signetics	74LS76	
SN74LS78	**Raytheon**	**74LS78**	**237**
	Signetics	74LS78	
SN74LS83A	**Raytheon**	**74LS83A**	**239**
	Signetics	74LS83A	
SN74LS85	Signetics	74LS85	
SN74LS86	Fairchild	74LS86	
	Raytheon	**74LS86**	**242**
	Signetics	74LS86	
SN74LS90	Fairchild	74LS90	
	Raytheon	**74LS90**	**243**
	Signetics	74LS90	
SN74LS92	Fairchild	74LS92	
	Raytheon	**74LS92**	**243**
	Signetics	74LS92	
SN74LS93	Fairchild	74LS93	
	Raytheon	**74LS93**	**243**
	Signetics	74LS93	
SN74LS95B	Fairchild	74LS95	
	Raytheon	74LS95B	
	Signetics	74LS95B	
SN74LS96	Signetics	74LS96	
SN74L00	National	DM74L00	
SN74L01	National	DM74L01	
SN74L02	National	DM74L02	
SN74L03	National	DM74L03	
SN74L04	National	DM74L04	
SN74L10	National	DM74L10	
SN74L123	National	DM74L123	
SN74L154	National	DM74L154A	
SN74L157	National	DM74L157A	
SN74L164	National	DM74L164	
SN74L192	National	DM74L192	
SN74L193	National	DM74L193	
SN74L20	National	DM74L20	
SN74L30	National	DM74L30	
SN74L42	National	DM74L42A	
SN74L51	National	DM74L51	
SN74L54	National	DM74L54	
SN74L55	National	DM74L55	
SN74L71	National	DM74L71	
SN74L72	National	DM74L72	
SN74L73	National	DM74L73	
SN74L74	National	DM74L74	
♦SN74L75	National	DM74L75	
SN74L78	National	DM74L78	
SN74L85	National	DM74L85	
SN74L86	National	DM74L86	
SN74L90	National	DM74L90	
SN74L91	National	DM74L91	
SN74L93	National	DM74L93	
SN74L95	National	DM74L95	
SN74L98	National	DM74L98	
SN74S00	Fairchild	74S00	
		9S00	
	National	DM74S00	
	Signetics	74S00	
SN74S03	Fairchild	74S03	
		9S03	
	National	DM74S03	
SN74S04	Fairchild	74S04	

♦ Discontinued

Bold face device numbers indicate manuracturers' data is provided in the IC Master on the pages noted.

Texas Instruments (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
SN74199	Signetics	74199	
SN7420	Fairchild	7420	
		9N20	
	Hitachi	HD2504	
	ITT	ITT7420	
	Motorola	MC7420	
	National	DM7420	
	Raytheon	7420	
	Signetics	7420	
	SW	SW7420	
	TRW	7420	
SN74200	Fairchild	93421	
	Intersil	IM5523	
	MMI	6531	
	Raytheon	RC5340	
	Signetics	N82S06	
	TI	SN74S201	
SN74206	Intersil	IM5533	
	MMI	6530	
	National	**DM74S206**	**751**
	Raytheon	RC5330	
	TI	SN74S301	
SN7422	Raytheon	7422	
SN74221	AMD	SN74221	
SN7423	Fairchild	7423	
		9N23	
	Motorola	MC7423	
	National	DM7423	
	SW	SW7423	
SN7425	Fairchild	7425	
		9N25	
	Motorola	MC7425	
	National	DM7425	
	SW	SW7425	
SN7426	Fairchild	7426	
		9N26	
	Hitachi	HD2560	
	ITT	ITT7426	
	Motorola	MC7426	
	National	DM7426	
	Signetics	N8T18	
		7426	
	SW	SW7426	
	TRW	7426	
SN7427	Fairchild	7427	
		9N27	
	Motorola	MC7427	
	National	DM7427	
	SW	SW7427	
SN74270	MMI	6205	
SN7428	ITT	ITT7428	
SN74283	Raytheon	74283	
SN74284	National	DM8875A	
SN74285	National	DM8875B	
SN74287	Fairchild	93426	
SN74290	TRW	74290	
SN74293	TRW	74293	
SN7430	Fairchild	7430	
		9N30	
	Hitachi	HD2508	
	ITT	ITT7430	
	Motorola	MC7430	
	National	DM7430	
	Signetics	7430	
	SW	SW7430	
	TRW	7430	
SN7432	Fairchild	7432	
		9N32	
	ITT	ITT7432	
	National	DM7432	
	Signetics	7432	
	SW	SW7432	
SN7433	ITT	ITT7433	
SN74365	National	DM8095	
SN74366	National	DM8096	
SN74367	National	DM8097	
SN74368	National	DM8098	
SN7437	Fairchild	7437	
SN7437	Fairchild	9N37	
	Hitachi	HD2552	
	ITT	ITT7437	
	Motorola	MC7437	
	National	DM7437	
	Signetics	7437	
	SW	SW7437	
	TRW	7437	
SN74370	MMI	6206	
SN7438	Fairchild	7438	
		9N38	
	Hitachi	HD2544	
	ITT	ITT7438	
	Motorola	MC7438	
	National	DM7438	
	Signetics	7438	
	SW	SW7438	
	TRW	7438	
SN74387	Fairchild	93416	
SN7440	Fairchild	7440	
		9N40	
	Hitachi	HD2501	
	ITT	ITT7440	
	Motorola	MC7440	
	National	DM7440	
	Signetics	7440	
	SW	SW7440	
	TRW	7440	
♦SN7441A	National	DM7441A	
	TI	SN74141	
♦SN7442	Fairchild	7442	
		9352	
	Hitachi	HD2536	
	ITT	ITT7442	
	Motorola	MC7442	
	National	DM7442	
	Raytheon	7442	
	Signetics	7442	
	SW	SW7442	
	TI	SN7442A	
♦SN7443	Fairchild	7443	
		9353	
	Hitachi	HD2537	
	ITT	ITT7443	
	Motorola	MC7443	
	Raytheon	7443	
	Signetics	7443	
	SW	SW7443	
	TI	SN7443A	
♦SN7444	Fairchild	7444	
		9354	
	Hitachi	HD2538	
	ITT	ITT7444	
	Motorola	MC7444	
	Raytheon	7444	
	Signetics	7444	
	SW	SW7444	
	TI	SN7444A	
SN7445	Fairchild	7445	
		9345	
	Hitachi	HD2531	
	ITT	ITT7445	
	Motorola	MC7445	
	National	DM7445	
	Raytheon	7445	
	Signetics	7445	
	SW	SW7445	
	TRW	7445	
♦SN7446	Fairchild	7446	
		9357	
	Hitachi	HD2553	
	ITT	ITT7446	
	Motorola	MC7446	
	National	DM7446	
	Signetics	7446	
	SW	SW7446	
	TI	SN7446A	
♦SN7447	Fairchild	7447	
	Hitachi	HD2532	
	ITT	ITT7447	
	Motorola	MC7447	
SN7447	National	DM7447	
	Signetics	7447	
	SW	SW7447	
	TI	SN7447A	
SN7448	Fairchild	7448	
		9358	
	ITT	ITT7448	
	Motorola	MC7448	
	National	DM7448	
	Signetics	7448	
	SW	SW7448	
SN7449	Fairchild	7449	
		9359	
	Motorola	MC7449	
SN7450	Fairchild	7450	
		9N50	
	Hitachi	HD2506	
	ITT	ITT7450	
	Motorola	MC7450	
	National	DM7450	
	Signetics	7450	
	SW	SW7450	
	TRW	7450	
SN7451	Fairchild	7451	
		9N51	
	Hitachi	HD2505	
	ITT	ITT7451	
	Motorola	MC7451	
	National	DM7451	
	Signetics	7451	
	SW	SW7451	
	TRW	7451	
SN7453	Fairchild	7453	
		9N53	
	Hitachi	HD2512	
	ITT	ITT7453	
	Motorola	MC7453	
	National	DM7453	
	Signetics	7453	
	SW	SW7453	
	TRW	7453	
SN7454	Fairchild	7454	
		9N54	
	Hitachi	HD2514	
	ITT	ITT7454	
	Motorola	MC7454	
	National	DM7454	
	Signetics	7454	
	SW	SW7454	
	TRW	7454	
SN7460	Fairchild	7460	
		9N60	
	Hitachi	HD2502	
	ITT	ITT7460	
	Motorola	MC7460	
	National	DM7460	
	Signetics	7460	
	SW	SW7460	
	TRW	7460	
SN7470	Fairchild	7470	
		9N70	
	Hitachi	HD2539	
	ITT	ITT7470	
	Motorola	MC7470	
	National	DM7470	
	Signetics	7470	
SN7472	Fairchild	7472	
		9N72	
	Hitachi	HD2529	
	ITT	ITT7472	
	Motorola	MC7472	
	National	DM7472	
	Signetics	7472	
	SW	SW7472	
	TRW	7472	
SN7473	Fairchild	7473	
		9N73	
	Hitachi	HD2515	
	ITT	ITT7473	
	National	DM7473	
	Signetics	7473	
SN7473	SW	SW7473	
SN7474	Fairchild	7474	
		9N74	
	Hitachi	HD2510	
	ITT	ITT7474	
	Motorola	MC7474	
	National	DM7474	
	Raytheon	7474	
	Signetics	7474	
	SW	SW7474	
	TRW	7474	
SN7475	Fairchild	7475	
		9375	
	Hitachi	HD2517	
	ITT	ITT7475	
	Motorola	MC7475	
	National	DM7475	
	Signetics	7475	
	SW	SW7475	
	TRW	7475	
SN7476	Fairchild	7476	
		9N76	
	Hitachi	HD2516	
	ITT	ITT7476	
	Motorola	MC7476	
	National	DM7476	
	Signetics	7476	
	SW	SW7476	
	TRW	7476	
♦SN7477	Fairchild	7477	
		9377	
	Motorola	MC7477	
♦SN7480	Fairchild	7480	
		9380	
	ITT	ITT7480	
	Motorola	MC7480	
	Signetics	7480	
		8268	
	SW	SW7480	
♦SN7481	Fairchild	93407	
	Hitachi	HM2501	
	Motorola	MC4004	
	Raytheon	7481	
	TI	SN7481A	
	TRW	7481	
SN7482	Fairchild	7482	
		9382	
	Hitachi	HD2513	
	ITT	ITT7482	
	National	DM7482	
	SW	SW7482	
♦SN7483	Fairchild	7483	
		9383	
	Hitachi	HD2535	
	ITT	ITT7483	
	Motorola	MC7483	
	National	DM7483	
	Raytheon	7483	
	Signetics	7483	
	TI	SN7483A	
♦SN7484	Motorola	MC7484	
	TI	SN7484A	
SN7485	Motorola	MC7485	
	National	DM7485	
	Signetics	7485	
	SW	SW7485	
	TRW	7485	
SN7486	Fairchild	7486	
		9N86	
	Hitachi	HD2526	
	ITT	ITT7486	
	Motorola	MC7486	
	National	DM7486	
	Raytheon	7486	
	Signetics	7486	
	SW	SW7486	
	TRW	7486	
♦SN7488	Intersil	IM5600	
	MMI	6230	
	Motorola	MCM4002	
	National	**DM7488**	**702**

♦ Discontinued

The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

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Manufacturer Device	Replacement Source	Device	IC Master Page
SN7488	TI	SN7488A	
SN7489	AMD	SN7489	
	Fairchild	7489	
	Hitachi	HM2502	
	Intersil	IM5501	
	National	**DM7489**	**704**
		DM7489	**741**
	NEC	μPB2089	
	Raytheon	7489	
	Signetics	N82S25	
	TRW	7489	
♦SN7490	Fairchild	7490	
		9390	
	Hitachi	HD2519	
	ITT	ITT7490	
	Motorola	MCM4023	
		MC7490	
	National	DM7490	
	Signetics	7490	
	SW	SW7490	
	TI	SN7490A	
	TRW	7490	
♦SN7491	Fairchild	7491	
		9391	
	Hitachi	HD2524	
	ITT	ITT7491	
	Motorola	MC7491	
	National	DM7491	
	Signetics	7491	
	SW	SW7491	
	TI	SN7491A	
♦SN7492	Fairchild	7492	
		9392	
	Hitachi	HD2521	
	ITT	ITT7492	
	Motorola	MC7492	
	National	DM7492	
	Signetics	7492	
	SW	SW7492	
	TI	SN7492A	
	TRW	7492	
♦SN7493	Fairchild	7493	
		9393	
	Hitachi	HD2520	
	ITT	ITT7493	
	Motorola	MC7493	
	National	DM7493	
	Signetics	7493	
	SW	SW7493	
	TI	SN7493A	
	TRW	7493	
SN7494	Fairchild	7494	
		9394	
	Hitachi	HD2533	
	ITT	ITT7494	
	Motorola	MC7494	
	Signetics	7494	
	SW	SW7494	
♦SN7495	Fairchild	7495	
		9395	
	Hitachi	HD2534	
	ITT	ITT7495	
	Motorola	MC7495	
	National	DM7495	
	Signetics	7495	
	SW	SW7495	
	TI	SN7495A	
SN7496	Fairchild	7496	
		9396	
	Hitachi	HD2546	
	ITT	ITT7496	
	Motorola	MC7496	
	National	DM7496	
	Signetics	7496	
	SW	SW7496	
	TRW	7496	
SN75S270	Signetics	82S130	
SN7510	Motorola	MC1410	
SN75107	AMD	SN75107	
	Fairchild	75107	
	ITT	ITT75107	
	Motorola	MC75107	
	National	**DS75107**	**475**
	Raytheon	RC75107A	
SN75108	AMD	SN74108	
	Fairchild	75108	
	ITT	ITT75108	
	Motorola	MC75108	
	National	**DS75108**	**475**
	Raytheon	RC75108A	
SN75109	AMD	SN75109	
	Fairchild	75109	
	ITT	ITT75109	
	Raytheon	RC75109	
SN75110	AMD	SN75110	
	Fairchild	75110	
	ITT	ITT75110	
	Motorola	MC75110	
	Raytheon	RC75110	
SN75112	Fairchild	75112	
SN75114	Fairchild	9614	
SN75115	Fairchild	9615	
SN75121	Fairchild	75121	
	Motorola	MC8T13	
	National	DS75121	
SN75122	Fairchild	75122	
	Motorola	MC8T14	
	National	DS75122	
SN75123	Fairchild	75123	
	Motorola	MC8T23	
	National	DS75123	
SN75124	Fairchild	75124	
	Motorola	MC8T24	
SN75125	National	DS75125	
SN75138	Silicon G	SG75138	
SN75140	Motorola	MC75140	
SN75150	Fairchild	75150	
	Raytheon	RC75150	
SN75152	Fairchild	9627	
SN75154	Fairchild	75154	
	ITT	ITT9311	
	National	DS75154	
	Raytheon	RC75154	
SN75180	National	DS8800	
SN75182	National	DS8820	
	Signetics	DM8820	
SN75183	National	DS8830	
	Signetics	DM8830	
SN75188	ITT	ITT1488	
	Motorola	MC1488	
	National	DS1488	
	Signetics	MC1488	
SN75189	ITT	ITT1489	
	Motorola	MC1489	
	National	DS1489	
	Signetics	MC1489	
SN7520	ITT	ITT7520	
	Motorola	MC7520	
	National	DS7520	
	Signetics	7520	
	Silicon G	SG7520	
SN75207	Fairchild	75207	
SN75208	Fairchild	75208	
SN7521	ITT	ITT7521	
	Motorola	MC7521	
	National	DS7521	
	Signetics	7521	
	Silicon G	SG7521	
SN7522	ITT	ITT7522	
	Motorola	MC7522	
	National	DS7522	
	Signetics	7522	
	Silicon G	SG7522	
SN75224	Fairchild	75224	
SN75225	Fairchild	75225	
SN7523	ITT	ITT7523	
	Motorola	MC7523	
	National	DS7523	
	Signetics	7523	
SN7523	Silicon G	SG7523	
SN75232	Fairchild	75232	
SN75233	Fairchild	75233	
SN75234	AMD	SN75234	
	Fairchild	75234	
	ITT	ITT75234	
SN75235	AMD	SN75235	
	Fairchild	75235	
	ITT	ITT75235	
	Motorola	MC75235	
SN75236	ITT	ITT75236	
SN75238	AMD	SN75238	
	Fairchild	75238	
SN75239	AMD	SN75239	
	Fairchild	75239	
SN7524	Fairchild	7524	
	ITT	ITT7524	
	Motorola	MC7524	
	National	DS7524	
	Signetics	7524	
	Silicon G	SG7524	
SN7525	Fairchild	7525	
	ITT	ITT7525	
	Motorola	MC7525	
	National	DS7525	
	Signetics	7525	
	Silicon G	SG7525	
SN7528	Fairchild	7528	
	ITT	ITT7528	
	Motorola	MC7528	
	National	DS7528	
	Silicon G	SG7528	
SN7529	Fairchild	7529	
	ITT	ITT7529	
	Motorola	MC7529	
	National	DS7529	
	Silicon G	SG7529	
SN75324	**National**	**DS75324**	**497**
	Raytheon	RC75324	
SN75325	AMD	SN75325	
	Fairchild	75325	
	ITT	ITT75325	
	Motorola	MC75325	
	National	**DS75325**	**495**
	Raytheon	RC75325	
	Silicon G	SG75325	
SN75326	Fairchild	75326	
	ITT	ITT75326	
SN75327	Fairchild	75327	
	ITT	ITT75327	
SN7534	Fairchild	7534	
	ITT	ITT7534	
	National	DS7534	
	Silicon G	SG7534	
SN7535	Fairchild	7535	
	ITT	ITT7535	
	National	DS7535	
	Silicon G	SG7535	
SN75361	ITT	ITT75361	
	National	**DS75361**	**498**
SN75362	**National**	**DS75362**	**499**
SN75365	ITT	ITT75365	
	Motorola	MC75365	
	National	**DS75365**	**501**
SN75368	Motorola	MC75368	
SN75369	Motorola	MMH0026	
	National	**DS0026**	**474**
SN75370	ITT	ITT75370	
SN7538	Fairchild	7538	
	National	DS7538	
	Silicon G	SG7538	
SN7539	Fairchild	7539	
	National	DS7539	
	Silicon G	SG7539	
SN75450	Fairchild	75450	
	Hitachi	HD2574	
	ITT	ITT75450	
	Motorola	MC75450	
	National	DS75450	
	Raytheon	RC75450	
	Signetics	75450	
SN75450	Silicon G	SG75450	
SN75451	Fairchild	75451	
	Hitachi	HD2575	
	ITT	ITT75451	
	Motorola	MC75451	
	National	DS75451	
	Raytheon	RC75451	
	Signetics	75451	
	Silicon G	SG75451	
SN75452	Fairchild	75452	
	Hitachi	HD2577	
	ITT	ITT75452	
	Motorola	MC75452	
	National	DS75452	
	Raytheon	RC75452	
	Signetics	75452	
	Silicon G	SG75452	
SN75453	Fairchild	75453	
	Hitachi	HD2578	
	ITT	ITT75453	
	Motorola	MC75453	
	National	DS75453	
	Raytheon	RC75453	
	Signetics	75453	
	Silicon G	SG75453	
SN75454	Fairchild	75454	
	Hitachi	HD2579	
	ITT	ITT75453	
	Motorola	MC75454	
	National	DS75454	
	Raytheon	RC75454	
	Signetics	75454	
	Silicon G	SG75454	
SN75460	Fairchild	75460	
	ITT	ITT75460	
	Motorola	MC75460	
	National	DS75460	
	Silicon G	SG75460	
SN75461	Fairchild	75461	
	ITT	ITT75461	
	Motorola	MC75461	
	National	DS75461	
	Silicon G	SG75461	
SN75462	Fairchild	75462	
	ITT	ITT75462	
	Motorola	MC75462	
	National	DS75462	
	Silicon G	SG75462	
SN75463	Fairchild	75463	
	ITT	ITT75463	
	Motorola	MC75463	
	National	DS75463	
	Silicon G	SG75463	
SN75464	Fairchild	75464	
	ITT	ITT75464	
	Motorola	MC75464	
	National	DS75464	
		SG75464	
SN75470	Fairchild	75470	
SN75471	Fairchild	75471	
SN75472	Fairchild	75472	
SN75473	Fairchild	75473	
SN75474	Fairchild	75474	
SN75480	National	DS8880	
SN75491	Fairchild	75491	
	Motorola	MC75491	
	National	DS75491	
SN75492	Fairchild	75492	
	Motorola	MC75492	
	National	DS75492	
SN75493	National	DS75493	
SN75494	National	DS75494	
SN76001	SGS	TBA820	
SN76104	Fairchild	μA732	
	Sprague	ULN-2120	
SN76105	Sprague	ULN-2122	
SN76111	Fairchild	μA767	
	Sprague	ULN-2121	
SN76113	Sprague	ULN-2128	
SN76115	Motorola	MC1310	
	RCA	CA1310	

♦ Discontinued

Bold face device numbers indicate manufacturers' data is provided in the IC Master on the pages noted.

Texas Instruments (cont'd)

Manufacturer Device	Replacement Source	Device	IC Master Page
SN76115	Sprague	ULN-2210	
SN76116	Fairchild	μA758	
	RCA	CA758	
	Sprague	ULN-2244	
SN76131	Fairchild	μA739	
	SGS	TBA231	
SN76149	Fairchild	μA749	
SN76177	Sprague	ULN-2277	
SN76226	Sprague	ULN-2216	
SN76242	Fairchild	μA780	
	RCA	CA3070	
	Sprague	ULN-2124	
SN76243	Fairchild	μA781	
	Sprague	ULN-2127	
SN76246	Fairchild	μA746	
	RCA	CA3071	
	Sprague	ULN-2114	
SN76266	RCA	CA3066	
SN76267	Fairchild	μA3067	
	RCA	CA3067	
SN76298	Motorola	MC1398	
	Sprague	ULN-2298	
♦SN76502	TI	TL441	
SN76530	Motorola	MC1330	
SN76564	Fairchild	3064	
	Motorola	MC1364	
	RCA	CA3064	
	Sprague	ULN-2264	
SN76565	Motorola	MC1364	
SN76591	Fairchild	μA1391	
	Motorola	MC1391	
SN76594	Fairchild	μA1394	
	Motorola	MC1394	
SN76600	Motorola	MC1350	
SN76635	Fairchild	μA720	
	Sprague	ULN-2137	
SN76642	Motorola	MC1357	
	Sprague	ULN-2113	
SN76643	Fairchild	2136	
	Signetics	ULN2111	
	Sprague	ULN-2111	
SN76650	Motorola	MC1352	
	RCA	CA1352	
SN76651	Motorola	MC1351	
SN76665	Fairchild	μA3064	
	RCA	CA3065	
SN76666	Fairchild	μA3065	
	Motorola	MC1358	
SN76669	Fairchild	μA2136	
	Motorola	MC1356	
	Sprague	ULN-2136	
SN76675	Fairchild	μA3075	
	Motorola	MC1375	
	Sprague	ULN-2129	
SN76678	Fairchild	μA753	
	Sprague	ULN-2209	
SN76689	Fairchild	μA3089	
	Sprague	ULN-2289	
TL514	Motorola	MC1514	
	Raytheon	RC1414	
		RM1514	
TL720	National	LM1414	
TMS0803	GI	C-593	
TMS0851	GI	CF-593	
TMS1101	Intersil	IM7501	
TMS1103	Signetics	1103	
TMS2101	RCA	MW4101	
♦TMS2102	Intersil	IM7552	
♦TMS2300	AMI	S8773	
♦TMS2500	AMI	S8773	
♦TMS2600	AMI	S8773	
	National	MM4230	
		MM5230	
♦TMS2800	National	MM4210	
♦TMS2900	AMI	S8773	
TMS3003	SGS	M127	
TMS3112	Fairchild	3348	
	Signetics	2518	
TMS3113	AMI	S2181A	
TMS3114	AMD	3114	
	AMI	S2181A	
TMS3120	SGS	M142	
	Signetics	2532	
TMS3121	Fairchild	3342	
TMS3128	Signetics	2521	
TMS3133	Fairchild	3355	
	Signetics	2533	
♦TMS3304	Motorola	MC1141	
TMS3409	Intersil	IM7780	
	Mostek	MK1007	
	SGS	M142	
TMS3412	AMI	S1685	
	SGS	M141	
TMS3413	SGS	M136	
♦TMS3414	AMI	S1685	
	SGS	M130	
TMS3417	Fairchild	3342	
TMS4000	GI	RO5-8192	
TMS4030	Intel	2107A	
	Western	RM1701	
TMS4033	Mostek	MK4102	
	National	**MM2102**	**759**
	SGS	M330	
	Signetics	21F02	
		2102-2B	
TMS4034	**National**	**MM2102**	**759**
	Signetics	2102	
TMS4035	Mostek	MK4116	
	National	**MM2101**	**756**
	Signetics	2102	
TMS4042	Signetics	2535	
		2602	
TMS4050	AMD	9050	
	RCA	MW4050	
TMS4051	RCA	MW4051	
TMS4060	AMD	9060	
	AMS	AMS7280	
	EA	EA4060	
	Intel	2107	
	Intersil	7280	
	National	**MM5280**	**794**
	NEC	μPD411	
	RCA	MW4060	
	Signetics	2680	
	Western	RM1701	
TMS4062	Nortec	6002	
	Western	RM1701	
TMS4070	Mostek	MK4116	
TMS4100	Motorola	MCM1130	
TMS4103	Motorola	MCM1131	
		MCM1132	
♦TMS4400	Motorola	MCM1140	
♦TMS4401	Motorola	MCM1141	
TMS4700	Mostek	MK30000	
TMS4800	EA	EA4800	
		EA4900	
	Mostek	MK28000	
TMS5001	GI	AY5-3600	
TMS6010	**AMI**	**S1757**	**400**
	GI	AY5-1013	
TMS6011	**AMI**	**S1883**	**400**
		S1883	**401**
	GI	AY3-1014	
		AY3-1015	
	RCA	MW7001	
	Western	TR1602	
TMS7001	Intersil	7001	
TMS8080	AMD	9080	
	Intel	8080	
	National	**DP8080A**	**1033**
TP4000	Motorola	MC14000	
	RCA	CD400	
	SSS	SCL4000	
TP4001	Motorola	MC14001	
	National	CD4001	
	RCA	CD4001	
	SSS	SCL4001	
TP4002	Motorola	MC14002	
	National	CD4002	
TP4002	RCA	CD4002	
	SSS	SCL4002	
TP4007	Motorola	MC14007	
	National	CD4007	
	RCA	CD4007	
	SSS	SCL4007	
TP4008	RCA	CD4008	
TP4009	National	CD4009	
	RCA	CD4009	
	SSS	SCL4009	
TP4010	National	CD4010	
	RCA	CD4010	
	SSS	SCL4010	
TP4011	National	CD4011	
	RCA	CD4011	
	SSS	SCL4011	
TP4012	Motorola	MC14012	
	National	CD4012	
	RCA	CD4012	
	SSS	SCL4012	
TP4013	Motorola	MC14013	
	National	CD4013	
	RCA	CD4013	
	SSS	SCL4013	
TP4014	National	CD4014	
	RCA	CD4014	
TP4015	National	CD4015	
	RCA	CD4015	
TP4016	National	CD4016	
	RCA	CD4016	
		CD4066	
TP4017	RCA	CD4017	
TP4018	RCA	CD4018	
TP4019	National	CD4019	
	RCA	CD4019	
TP4020	RCA	CD4020	
TP4021	National	CD4021	
	RCA	CD4021	
TP4022	RCA	CD4022	
TP4023	Motorola	MC14023	
	National	CD4023	
	RCA	CD4023	
	SSS	SCL4023	
TP4024	RCA	CD4024	
TP4025	Motorola	MC14025	
	RCA	CD4025	
	SSS	SCL4025	
TP4027	Motorola	MC14027	
	National	CD4027	
	RCA	CD4027	
	SSS	SCL4027	
TP4028	National	CD4028	
	RCA	CD4028	
TP4029	National	CD4029	
	RCA	CD4029	
TP4030	RCA	CD4030	
TP4035	RCA	CD4035	
TP4040	RCA	CD4040	
TP4042	RCA	CD4042	
TP4043	RCA	CD4043	
TP4044	RCA	CD4044	
TP4047	Motorola	MC14047	
	RCA	CD4047	
TP4049	National	CD4049	
	RCA	CD4049	
TP4050	National	CD4050	
	RCA	CD4050	
TP4051	RCA	CD4051	
TP4052	RCA	CD4052	
TP4053	RCA	CD4053	
TP4071	RCA	CD4071	
TP4072	RCA	CD4072	
TP4073	RCA	CD4073	
TP4075	RCA	CD4075	
TP4078	Motorola	MC14078	
	RCA	CD4078	
TP4081	RCA	CD4081	
TP4082	RCA	CD4082	
TP4315	RCA	CD4069	
TP4320	RCA	CD4067	
TP4360	Fairchild	F40160	
TP4360	Motorola	MC14160	
	National	MM74C160	
TP4361	Fairchild	F40161	
	Motorola	MC14161	
	National	MM74C161	
TP4362	Fairchild	F40162	
	Motorola	MC14162	
	National	MM74C162	
TP4363	Fairchild	F40163	
	Motorola	MC14163	
	National	MM74C163	
TP4507	RCA	CD4030	
		CD4070	
TP4511	Motorola	MC14511	
	RCA	CD4511	
TP4512	Motorola	MC14512	
TP4518	Motorola	MC14518	
	RCA	CD4518	
TP4519	Motorola	MC14519	
TP4520	Motorola	MC14520	
	RCA	CD4520	
TP4522	Motorola	MC14522	
TP4526	Motorola	MC14526	
TP4531	Motorola	MC14531	
TP4581	Motorola	MC14581	
TP4582	Motorola	MC14582	

Toshiba

TC4061	RCA	CD4061	

Western Digital

BR1941	SMC	COM5016	
RM1701	Intel	2107	
	TI	**TMS4030**	**854**
		TMS4060	**854**
RM4096	Mostek	MK4096	
TR1402	GI	AY5-1014	
		AY5-1015	
TR1402A	GI	AY5-1013	
TR1602	**AMI**	**S1883**	**400**
		S1883	**401**
	GI	AY3-1014	
		AY3-1015	
		AY5-1013	
	SMC	COM2017	
		COM2502	
	TI	TMS6011	

Zilog

Z80-CPU	Mostek	MK3880
Z80-CTC	Mostek	MK3882
Z80-CTU	Mostek	MK3882
Z80-DMA	Mostek	MK3883
Z80-PIO	Mostek	MK3881
Z80-SIO	Mostek	MK3884

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The manufacturers report their devices can be used as direct replacements. Performance details often differ, so compare the specifications considering your requirements.

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(408) 732-2400
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Datel Systems
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Electronic Arrays, Inc.
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(415) 964-4321
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Electronic Arrays, GmbH, Tel: (089) 785 3168
Intl **Yugoslavia, Maribor**
Ellyptic AG, Tel: 1330589

EMM/Semi

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Phoenix, Arizona 85017
(602) 263-0202
TWX: (910) 951-1383

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EMM/Semi, (213) 644-9881
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GA **Atlanta**
Gentry Assoc., (404) 237-7272
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NC **Burlington**
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Contec, (613) 225-0363
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Cantec, (416) 457-4455

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Semicomp Corp., (408) 736-2330
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Arrow, (513) 253-9176
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Exar Integrated Systems

Exar Integrated Systems, Inc.
750 Palomar Ave.
Sunnyvale, California 94086
(408) 732-7970
TWX: (910) 339-9233
Specific product information:
Product Marketing
Application engineering:
Applications Engineering
Literature:
Local Representative or Distributor
Price and delivery:
Local Representative or Distributor
Place an order:
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Follow-up an order:
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Dy-Tronix, (816) 737-1100
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R.F.Q. Limited, (514) 626-8324
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R. Ohm Electronics (H.K.) Co. Ltd., Tel: 3-691-779, 3-686841
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Semiconductor Concepts, (516) 273-1234
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Huntingdon Valley
Hall-Mark Electronics, (215) 355-7300
TX **Austin**
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Hall-Mark Electronics, (512) 837-2814
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Component Specialties, (214) 357-6511
Hall-Mark Electronics, (214) 231-6111
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Component Specialties, (713) 771-7237
Hall-Mark Electronics, (713) 781-6100
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WA **Seattle**
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Taylor Electric Co., (414) 241-4321
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Hall-Mark Electronics, (414) 476-1270
Can **Montreal, Quebec**
Future Electronics, (514) 735-5775
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R-A-E Industrial Electronics, (604) 687-2621
Intl **Argentina**
Rayo Electronica SRL, Tel: 37-9890
Intl **Australia**
A.J. Ferguson, Tel: 269-1244
Intl **India, Bombay**
Zenith Electronics Jaikishan Nivas, Tel: 36-7717
Intl **New Zealand, Auckland**
Professional Electronics Ltd., Tel: 469-450

Fairchild Semiconductor

Fairchild Camera and Instrument Corp.
Integrated Circuits Group
464 Ellis Street
Mountain View, California 94042
(415) 962-5011
TWX: (910) 379-6435

Fairchild Camera and Instrument Corp.
Microsystems Division
1725 Technology Drive
San Jose, California 95110
(408) 998-0123
TWX: (910) 338-0558

Specific product information:
Local field sales office or franchised distributor, or contact the specific product marketing department at 464 Ellis Street, Mountain View, CA
Request through main switchboard: (415) 962-5011:
Linear Product Mktg. (Analog, Hybrid)
Bipolar Memory Product Mktg. (Memory, ECL, Macrologic)
Digital Product Mktg. (Bipolar and CMOS)
MOS Product Marketing (MOS, CCD, Memory)
Power Transistor Product Marketing
Small Signal Product Marketing
Diode Product Marketing (415) 479-8000
Optoelectronic Product Marketing (415) 493-3100
Microprocessors: Microsystems Division (408) 998-0123
Application engineering:
See Product Information
Literature:
Local field office, representative or franchised distributor.
Price and delivery:
Local field sales office or franchised distributor.
Place an order:
Local field sales office or franchised distributor.
Follow-up an order:
Customer Service Center, 401 Ellis Street, Mountain View, CA 94042, (415) 962-4486
All other information:
Fairchild Information Line, (415) 962-4401

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Simpson Associates Inc., (303) 794-8381

CT **Ridgefield**
Phoenix Sales Co., (203) 438-9644

FL **Altamonte Springs**
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Lectromech, (305) 920-2291
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Lectromech (813) 527-2406

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Cartwright & Bean, (404) 255-5262

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B.C. Electronic Sales, (319) 364-7253

IL **Chicago**
Field Sales Office, (312) 640-1000
Elk Grove Village
Micro Sales (312) 956-1000

IN **Fort Wayne**
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Field Sales Office, (317) 849-5412
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KS **Olathe**
B. C. Electronic Sales, (913) 888-6680

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Spectrum Associates, (617) 237-2796

MD **Bladensburg**
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Delta III Associates, (301) 779-0977

MI **Detroit**
Rathsburg Associates, (313) 882-1717
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Field Sales Office, (313) 425-3250

MN **Edina**
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MO **Hazelwood**
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Cartwright & Bean, (919) 781-6560

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Field Sales Office, (505) 265-5601
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NY **Endwell**
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Tri-Tech Electronics, (716) 223-5720
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Tri-Tech Electronics, (315) 446-2881
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Lorac Sales, (516) 293-2970
Poughkeepsie
Field Sales Office, (914) 452-4200
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Field Sales Office, (716) 223-7700

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Field Sales Office, (216) 461-8288
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Components, Inc., (513) 866-0661

OK **Tulsa**
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Technical Marketing (918) 622-5984

OR **Portland**
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PA **Fort Washington**
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BGR Associates, (215) 643-4111
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Components, Inc., (412) 833-9380

TN **Knoxville**
Cartwright & Bean, (615) 693-7450
Memphis
Cartwright & Bean, (901) 276-4442

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Field Sales Office, (214) 234-3391
Technical Marketing, (214) 387-3601
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Field Sales Office, (713) 771-3547
Technical Marketing, (713) 777-9228

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WA **Bellevue**
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Can **Mississauga, Ont.**
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R. N. Longman Sales, (416) 625-6799
Montreal, Quebec
R. N. Longman Sales, (514) 382-2552

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Fairchild Australia Pty, Ltd., Tel: 929-6711

Intl **Austria, Vienna**
Fairchild Electronics, Tel: 0222 635821

Intl **Brazil, Sao Paulo**
Fairchild Semiconductors, Tel: 66-9092

Intl **France, Paris**
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Leonberg
Fairchild Camera & Instrument GmbH, Tel: 07152 41026
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TDK-Fairchild, Tel: 03-400-8351

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Fairchild Semiconductor Ltd., Tel: 00445 8932891

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Intl **Sweden, Stockholm**
Fairchild Semiconductor AB, Tel: 00468-449255

Intl **Taiwan, Taipei**
Fairchild Semiconductor (Taiwan) Ltd., Tel: 573205

Intl **United Kingdom, Herts**
Fairchild Camera and Instrument (UK) Ltd., Tel: 00441 4407311

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Hamilton/Avnet Electronics, (714) 279-2421
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Semiconductor Specialists, (612) 854-8841

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Hamilton/Avnet Electronics, (314) 731-1144

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Sterling Electronics, (201) 442-8000
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Hamilton/Avnet Electronics, (516) 333-5800
Schweber Electronics, (516) 334-7474
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Sheridan Sales Company, (216) 831-0130
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Hamilton/Avnet Electronics, (216) 461-1400
Pioneer/Cleveland, (216) 587-3600
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Pioneer/Dayton, (513) 236-9900
Hamilton/Avnet Electronics, (513) 433-0610
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Hallmark Electronics, (214) 231-6111
Schweber Electronics, (214) 661-5010
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Schweber Electronics, (713) 784-3600
Sterling Electronics, (713) 627-9800
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Cam Gard Supply Ltd., (403) 426-1805
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Vancouver, BC
R.A.E., (604) 687-2621
Winnepeg, Man.
Cam Gard Supply Ltd., (204) 786-8401
Fredericton, NB
Cam Gard Supply Ltd., (506) 455-8891
Moncton, NB
Cam Gard Supply Ltd., (506) 855-2200
Saint John, NB
Cam Gard Supply Ltd., (506) 657-4666
Halifax, NS
Cam Gard Supply Ltd., (902) 454-8581
Downsview, Ont.
Semad Electronics, Ltd., (416) 635-9880
Mississauga, Ont.
Hamilton/Avnet Intn'l Ltd., (416) 677-7432
Ottawa, Ont.
Future Electronic Corp., (613) 232-7757
Hamilton/Avnet Intn'l, (613) 226-1700
Semad Electronics Ltd., (613) 722-6571
Rexdale, Ont.
Future Electronics Corp., (416) 677-7820
Willowdale, Ont.
Electro Sonic Industrial Sales Ltd. (Toronto), (416) 494-1666
St. Laurent, PQ
Hamilton/Avnet Intn'l Canada, Ltd., (514) 331-6443
Dorval, PQ
Semad Electronics Ltd., (514) 636-4614
Montreal, Quebec
Future Electronics Corp., (514) 735-5775
Regina, Sas.
Cam Gard Supply Ltd., (306) 525-1317
Saskatoon, Sas.
Cam Gard Supply Ltd., (306) 652-6424

Ferranti Electric

Ferranti Electric
East Bethpage Road
Plainview, New York 11803
(516) 293-8383
TWX: (510) 224 6483

Sales Offices & Representatives

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Component Sales, (303) 750-2254
FL **Orlando**
Publicover Associates, (305) 898-9361
IL **Morton Grove**
T Squared Associates, (312) 965-1515
NC **Raleigh**
Remco, (919) 834-5820
NJ **Wallington**
Com-Tech Sales, (201) 935-5454
NY **New Hyde Park**
Comp-Tech Sales, (516) 593-2628
Syracuse (Upstate)
MMI Sales, (315) 455-5919
Intl **United Kingdom, Chadderton, Oldham**
Ferranti, Ltd., Tel: 061-624 0515
Intl **West Germany, Munich**
Ferranti GmbH, Tel: (089) 293 871

Distributors

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Joseph McKeever and Co., Ltd., Tel: 681604, 681582
Intl **United Kingdom**
Broadheath, Cheshire
Woolley Components Ltd., Tel: 061-928 2289/7425
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C.N. Rood b.v., Tel: 02-35 21 35
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Intl **Germany, Munich**
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Telex: 138275

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Inelco Nederland, Tel: (020) 934824
Intl **Norway, Oslo**
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Electronic Building Elements, Tel: 78 92 21
Intl **Spain, Barcelona**
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Intl **Sweden, Stockholm**
Nordisk Electronik AB, Tel: (08) 248340
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(408) 735-9370

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ITT Semiconductors

ITT Semiconductors
U.S. Division
74 Commerce Way
Woburn, Massachusetts 01801
(617) 935-7910
TWX: 710-342-0764

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Linear ..... Ext 233
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Cam-Gard Supply, Ltd., (204) 786-8481

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Lithic Systems
10101 Bubb Road
P.O. Box 869
Cupertino, CA 95014
(408) 257-2004

Litronix

Litronix, Inc.
19000 Homestead Road
Cupertino, California 95014
(408) 257-7910
TWX: (910) 338-0022

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1235 Walt Whitman Road
Melville, New York 11746
(516) 293-3850

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Micropac Industries

Micropac Industries, Incorporated
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(214) 272-3571
TWX: (910) 860-5186
All other information:
All Inquiries: Marketing Department ..... Ext 20, 21, 24

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Micro Power Systems
3100 Alfred Street
Santa Clara, California 95050
(408) 247-5350
TWX: (910) 338-0154

Mitel Semiconductor

Mitel Semiconductor Inc.
18 Airport Blvd.
Bromont, Quebec, Canada, JOE 1L0
(514) 534-2321
Telex: 05-267474
Specific Product Information:
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Telecommunication ..... Tam Nguyen
Application Engineering:
Siltek CMOS ..... Tam Nguyen
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MOS Technology

MOS Technology, Inc
Valley Forge Corporate Center
950 Rittenhouse Road
Norristown, PA 19401
(215) 666-7950
TWX: (510) 660-4033
Specific product information:
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Mostek Corp.

Mostek Corporation
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(214) 242-0444
TWX: (910) 860-5945
Telex: 730423

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PA **Willow Grove**
Harry Nash Assoc., (215) 657-2213
TX **Dallas**
Ammon & Rizos, (214) 233-5591
Houston
Ammon & Rizos, (713) 781-6240
WA **Seattle**
Northwest Mkt. Assoc., (206) 455-5846

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Panasonic

Panasonic
Matsushita Electric Corporation
Industrial Division
1 Panasonic Way
Secaucus, New Jersey 07094
(201) 348-7275
Specific product information:
IC's and Solid State Products Product Manager, Terry Kobayashi
Application engineering:
Chicago, Arthur Suyama ..... ext (312) 455-3105
New Jersey, Terry Kobayashi ..... ext (201) 348-7275
Price and delivery:
See Local Representatives
Place an order:
See Local Representatives
Follow-up an order:
See Local Representatives

Sales Offices & Representatives

AL **Huntsville**
Rep., Inc., (205) 881-9270
AZ **Phoenix**
Arrowhead Sales Corp., (602) 277-7148
CA **Newport Beach**
West, Inc., (714) 540-9040
San Jose
Allgood North, (408) 288-6731
CO **Arvada**
Arrowhead Sales Corp., (303) 423-5556
FL **Casselberry**
EIR, Inc., (305) 830-9600
GA **Tucker**
Rep, Inc., (404) 938-4358
IA **Des Moines**
Beams, (515) 255-1148
IL **Chicago**
Brock & Cushman, (312) 622-4110
KS **Shawnee Mission**
B.E.A.M.S., Inc., (913) 631-0300
MA **Allston**
Vector Sales, (617) 787-2790
MD **Elliott City**
Tom Davis Marketers, (301) 461-2209
MI **Detroit**
Nicon Assoc., (313) 341-7688
MN **Minneapolis**
Jos-Co/Melius, (612) 854-4270
MO **St. Louis**
B.E.A.M.S., Inc., (314) 569-1060
NC **Winston Salem**
Murcota Corp., (919) 722-9445
NJ **Plainfield**
MEG Electronic Sales, (201) 757-4332, (212) 233-9059
NY **Ontario Center**
Kehoe Component Sales (315) 524-2491
OH **Columbus**
Tom Mulligan & Assoc., (614) 457-2242
OR **Portland**
Electronic Sources, (503) 292-0634
PA **King of Prussia**
Monteiro Assoc., Inc., (215) 265-0634
TX **Addison**
Dunbar Assoc., (214) 239-7151
VA **Fairfax**
Tom Davis Marketers, (703) 591-7390
WA **Bellevue**
Electronic Sources, (206) 453-0800
Can **Dollard Des Ormeaux, Quebec**
R.F.Q., Ltd., (514) 626-8324
Mississauga, Ontario
R.F.Q., Ltd., (416) 626-1445

Distributors

AZ **Phoenix**
Electronic Parts, (602) 277-7281
CA **Los Angeles**
Western Electromotive/Shephard, (213) 820-3777
FL **Dania**
Arco Distributors, (305) 925-1999
West Palm Beach
Nurmi Industrial Division, (305) 684-0320
GA **Tucker**
Resistacap, (404) 938-4358
MI **Detroit**
RS Electronics, (313) 491-1000
Farmington
Diplomat/Northland (313) 477-3200
MN **Minneapolis**
Joel Company, (612) 545-5669
Thief River Falls
Digi-Key Corp., (218) 681-2550
NJ **Plainfield**
Mars Electronics, (201) 757-4332, (212) 233-9059
NY **Ontario Center**
Pace Electronic Products, (315) 524-2491
OH **Cincinnati**
Midwest Equipment Co.
OR **Portland**
Electronic Sources, (503) 293-0701
PA **Levittown**
Indisco, (215) 785-6565
TX **Addison**
Computer Components Corp., (214) 239-7151
UT **Salt Lake City**
Standard Supply Company, (801) 355-2971
WA **Bellevue**
Electronic Sources, (206) 453-0800
Can **Toronto, Ontario**
Westburne Haldane Electronics (416) 789-4181

Plessey Semiconductors

Plessey Semiconductors
1674 McGaw Avenue
Santa Ana, California 92705
(714) 540-9945

TWX: (910) 595-1930
Application engineering:
Walt Boris ..... ext. 49
Literature:
Donna Clark ..... ext. 48
Price and delivery:
Donna Clark ext.48
Follow-up and order:
Donna Clark ..... ext. 48

Sales Offices & Representatives

AL **Huntsville**
REMCO, (205) 883-9260
REMCO-Huntsville, (205) 533-6029
AZ **Phoenix**
The Thorson Company, (602) 956-5300
CA **Goleta**
The Thorson Company, (805) 964-8751
Irvine
Western Regional Sales Office, (714) 540-9945
Los Angeles
The Thorson Company, (213) 476-1241
Marina del Rey
Relcom, (213) 822-1187
Mountain View
The Thorson Company, (415) 964-9300
San Diego
Littlefield & Smith Assoc., (714) 277-8044
Tustin
The Thorson Company, (714) 544-5121
CO **Denver**
West/Mark Denver, (303) 433-7181
CT **Milford**
Wayland Engineering Sales/Conn., (203) 878-3755
FL **St. Petersburg**
Kirkwood Associates, (813) 894-8240
IA **Cedar Rapids**
Engineering Services Co., (319) 362-0503
IL **Schiller Park**
Midwestern Regional Sales Office, (312) 678-3280/1
Wilmette
R-Tech, (312) 256-6783
IN **Fort Wayne**
RF Specialists, (219) 485-8982
KS **Prairie Village**
Engineering Services Co., (913) 649-4000
MA **Natick**
Wayland Engineering Sales, (617) 655-6080
MD **Ellicott City**
Applied Engineering Consultants, (301) 465-1272 (Baltimore), (202) 953-2808 (Washington)
MI **Southfield**
Luebbe Sales Company, (313) 357-0355
MN **Minneapolis**
Technical Associates, (612) 929-6721
MO **St. Louis**
Engineering Services Co., (314) 997-1515
NC **Raleigh**
Remco-Raleigh, (919) 828-3009
NY **Plainview**
Erde Associates, (516) 822-5357
Syracuse
Syracuse Technical Representatives, (315) 487-7777
OH **Cincinnati**
Luebbe Sales Company, (513) 871-4211
Cleveland
Luebbe Sales Company, (216) 333-0425
Dayton
Luebbe Sales Company, (513) 294-0426
PA **Delmont**
Luebbe Sales Company, (412) 468-4019
Huntingdon Valley
Dick Knowles Associates, (215) 947-5641
TN **Jackson**
Remco-Jackson, (901) 424-0142
TX **Fort Worth**
W. Pat Fralia Company, (817) 640-9101
Houston
W. Pat Fralia Company, (713) 772-1572
VA **Arlington**
Applied Engineering Consultants, (703) 524-6630
Woodbridge
Applied Engineering Consultants, (703) 550-9429
WA **Olympia**
Bergford & Associates, (206) 866-2001
Can **Downsview, Ontario**
Plessey Canada, Ltd., (416) 661-3711
Intl **Australia, Villawood N.S.W.**
Plessey Ducon Py, Ltd., Tel: 72 0133
Intl **Austria, Vienna**
Plessey GmbH., Tel: 63 45 75
Intl **Bene-Lux, Brussels**
Plessey S.A. Tel: 74 5971
Intl **Brazil, Sao Paulo**
Plessey Brazil, Tel: (011) 269 0211
Intl **England, Ilford, Essex, (for Mid & Eastern Europe)**
Plessey Co., Ltd., Tel: 01-478 3040
Intl **Eire, Dublin**
Plessey Ireland, Ltd., Tel: 75 84 51/2
Intl **France, Paris**
Plessey France S.A., Tel: 727 43 49
Intl **Hong Kong**
Plessey Co., Ltd., Tel: 5-452145
Intl **Italy, Milan**
Plessey S.p.A., Tel: 349 1741
Japan
Osaka
Cornes & Co., Ltd., Tel: 532-1012/1019
Tokyo
Cornes & Co., Ltd., Tel: 272-5771

Distributors

CA **Culver City**
Ancrona, (213) 641-4064
Newport Beach
Semicomp Corp., (714) 833-3070
San Diego
Intermark, (714) 453-9005
Santa Ana
Ancrona, (714) 547-8424
Sunnyvale
Semicomp Corp., (408) 736-2330
IL **Chicago**
Semiconductor Specialists, (312) 279-1000
IN **Indianapolis**
Semiconductor Specialists, (317) 243-8271
MD **Ellicott City**
Applied Engineering Consultants, (301) 465-1272 (Baltimore), (301) 953-2802
MI **Detroit**
Semiconductor Specialists, (313) 255-0300
MN **Minneapolis**
Semiconductor Specialists, (612) 854-8841
MO **Hazelwood**
Semiconductor Specialists, (314) 731-2400
Kansas City
Semiconductor Specialists, (816) 452-3900
NY **Plainview**
Plainview Electronics Supply Corp., (516) 822-5357
OH **Dayton**
Semiconductor Specialists, (513) 278-9455
PA **Pittsburg**
Semiconductor Specialists, (412) 781-8120
TX **Dallas**
Semiconductor Specialists, (214) 358-5211
WI **Milwaukee**
Semiconductor Specialists, (414) 257-1330

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Plessey Semiconductors (cont)

Intl **Belgium, Antwerp**
Mulder Hardenberg, Tel: 031/68 70 20
Intl **France, Paris**
Scientech, Tel: 609 91 36
Intl **Italy, Milan**
Melchioni, Tel: 5794

Power Monolithics

Power Monolithics
121 International Drive
Corpus Christi, Texas 78401
(512) 883-6251

Sales Offices & Representatives

AZ **Phoenix**
Power Monolithics, (602) 996-1010
CA **Carson**
Power Monolithics, (213) 537-8341
Sunnyvale
Power Monolithics, (408) 738-2541
FL **Largo**
Power Monolothics, (813) 596-5151
IL **Arlington Heights**
Power Monolithics, (312) 593-2550
MA **Lexington**
Power Monolithics, (617) 861-8585
MD **Baltimore**
Power Monolithics, (301) 465-1133
MN **Minneapolis**
Power Monolithics, (612) 935-6194
NC **Greensboro**
Power Monolithics, (919) 274-5745
NJ **Cherry Hill**
Power Monolithics, (516) 694-4200
Northern New Jersey
Power Monolithics, (516) 694-4200
NY **Melville**
Power Monolithics, (516) 694-4200
Poughkeepsie
Power Monolithics, (914) 297-4800
Rochester
Power Monolithics, (716) 454-6770
OH **Cleveland**
Power Monolithics, (216) 585-7808
OK **Oklahoma**
Power Monolithics, Enterprise 2-183
PA **Norristown**
Power Monolithics, (215) 279-5644
TX **Dallas**
Power Monolithics, (214) 341-5130
Houston
Power Monolithics, (713) 464-6554
VA **Fairfax**
Power Monolithics, (703) 273-6138
McLean
Power Monolithics, (703) 356-0141
Can **Toronto, Ontario**
Vecco Lambda Ltd., (416) 486-0794
Pointe-Claire, Quebec
Vecco Lambda Ltd., (514) 697-6520
Intl **England, High Wycombe Bucks**
Lambda Electronics, High Wycombe, Tel: 36386/7/8
Intl **France, Orsay**
Lambda Electronique, S.A., Tel: 012-1487
Intl **Germany, Achern**
Lambda Netzgerate GmbH, Tel: (078) 41-5527
Intl **Israel, Tel Aviv**
IsLambda Electronics Ltd., Tel: 240-672
Intl **Japan, Yokohama**
Pan Electron Inc., Tel: (045) 471-8811
Intl **Mexico, Mexico City**
Mexitex, S.A., Tel: 5-36-09-10 or 5-43-03-77

Precision Monolithics

Precision Monolithics, Inc.
1500 Space Park Drive
Santa Clara, California 95050
(408) 246-9222
TWX: (910) 338-0528
Specific product information:
Local Field Sales Office
Literature:
Local Field Sales Office
Follow-up an order:
Customer Service..... ext 171

Sales Offices & Representatives

AL **Huntsville**
W.A. Brown Components, (205) 539-4411
AZ **Tempe**
Argus Sales, (602) 967-8709
CA **Mountain View**
Thresum Assoc., (408) 965-9180
Newport Beach
PMI, (714) 752-1760
CO **Denver**
Thorson Company, (303) 759-0809
CT **Wallingford**
Com-Sale, (203) 269-7964
FL **Clearwater**
DYNE-A-MARK, (813) 441-4702
Ft. Lauderdale
DYNE-A-MARK, (305) 771-6501, (305) 944-5031 (Miami)
GA **Chamblee**
W.A. Brown Components, (404) 455-0405
IA **Cedar Rapids**
Comstrand, (319) 377-1575
IL **Arlington Heights**
PMI, (312) 437-6697
Rolling Meadows
Sumer Inc., (312) 394-4900
IN **Indianapolis**
Ihrig Assoc., (317) 783-7630
KS **Olathe**
Technical Representatives, (913) 782-1177
MA **Waltham**
COM-SALE, (617) 890-0011
MD **Baltimore**
Steimier Assoc., (301) 944-8262
MI **Detroit**
A. Blumenberg, (313) 557-1934
MN **Minneapolis**
Comstrand, (612) 571-0000
MO **Hazelwood**
Technical Representatives, (314) 731-5200
NC **Raleigh**
W.A. Brown Components, (919) 781-9426
NJ **Cherry Hill**
Stemler Assoc., (609) 966-4070
NM **Albuquerque**
Thorson Company, (505) 265-5655
NY **Jericho**
J. Square Marketing, (516) 433-5330
Rochester
Ontec Assoc., (716) 464-8636
Wantagh
PMI, (516) 785-3331
OH **Cleveland**
Del Steffen & Assoc., (216) 461-8333
Dayton
Del Steffen & Assoc., (513) 293-3145
Lexington
Del Steffen & Assoc., (419) 884-2313
OR **Portland**
SJI, (503) 224-0344
PA **Warminster**
Stemler Assoc., (215) 644-3477
TX **Houston**
Oeler & Menelaides, (713) 772-0730
Richardson
Oeler & Menelaides, (214) 234-6334
VA **Alexandria**
Stemler Assoc., (703) 548-7818
WA **Seattle**
SJI, (206) 624-9020
Can **Dollard Des Oreaux, Quebec**
RFQ Limited, (514) 626-8324
Mississauga, Ontario
RFQ Limited, (416) 626-1445
Intl **Australia, Crows Nest, NSW**
Cema, Tel: 439-4655
Intl **Austria, Vienna**
Ing. Otto Folger, Tel: 0222 656 23 64
Intl **Belgium, Brussels**
Bourns (Belgium) N.V., Tel: 02 218 2005
Intl **Denmark, Bagsvaerd-Copenhagen**
E. Friis-Mikkelsen A/S, Tel: 01 98 63 33
Intl **Eastern Europe, Vienna**
Eltrans, Tel: 0222 24 71 37
Intl **Finland, Helsinki**
Oy Chester Ab, Tel: 90-735 774
Intl **France, Paris**
Ohmic S.A., Tel: 01-203 9633
Intl **Germany, Stuttgart**
Bourns GmbH, Tel: 0711-24 29 36
Intl **Greece, Athens**
M.N. Kourakos, Tel: 638-747 637
Intl **India, Palo Alto, CA 94306**
Fegu, Inc., Tel: (415) 493-1788
Intl **Iran, Tehran**
Berkeh Company, Ltd., Tel: 831 564
Intl **Israel, Tel Aviv**
Rapac Electronics, Ltd., Tel: 023-477 115
Intl **Italy, Milan**
Technic S.R.L., Tel: 02-32 56 88
Intl **Japan, Tokyo**
Toyo Trading Co., Ltd., Tel: 279-0771
Intl **Netherlands, The Hague**
Bourns (Nederland) B.V., Tel: 070-88 93 18
Intl **Norway, Strommen**
A/S Kjell Bakke, Tel: 02-71 18 72
Intl **Portugal, Lisbon**
Telectra S.A.R.L., Tel: 119-68 60 72
Intl **South Africa, Johannesburg**
Associated Electronics (Pty) Ltd., Tel: 724 5395
Intl **South America, Mountain View, CA 94043**
Intectra, Tel: (415) 967-8818
Intl **Spain, Madrid**
Hispano Electronica S.A., Tel: 01-233 1601
Intl **Sweden, Akers Runo**
Ab Elecktroutensilier, Tel: 0764 20 110
Intl **Switzerland, Zug**
Bourns (Schweiz) Ag, Tel: 042-23 22 42
Intl **Turkey, Ankara**
Nuekleer Elektronik Ltd., Tel: 18 72 70
Intl **United Kingdom, Hounslow, Middlesex**
Bourns (Trimpot) Ltd., Tel: 01-572-6531
Intl **Yugoslavia, Zagreb**
Unitrade-Podravka, Tel: 041-44 80 55

Distributors

AZ **Phoenix**
Sterling Electronics, (602) 258-4531
CA **Chatsworth**
Westates Electronics Corp., (213) 341-4411
Gardena
Bell Industries, (213) 321-5802
San Diego
Intermark Electronics, (714) 279-5200
Sunnyvale
Bell Industries, (408) 734-8570
Intermark Electronics, (408) 738-1111
CO **Wheatridge**
Century Electronics, (303) 424-1985
FL **Ft. Lauderdale**
Hallmark Electronics, (305) 971-9280
Orlando
Hallmark Electronics, (305) 855-4020
IL **Elk Grove Village**
Hallmark Electronics, (312) 437-8800
IN **Indianapolis**
Pioneer Electronics, (317) 849-7300
MA **Dedham**
Gerber Electronics, (617) 329-2400
Lexington
Harvey Electronics, (617) 861-9200
MD **Baltimore**
Hallmark Electronics, (301) 796-9300
MI **Livonia**
Pioneer Electronics, (313) 525-1800
MN **Bloomington**
Hallmark Electronics, (612) 884-9056
MO **Earth City**
Hallmark Electronics, (314) 291-5350
NC **Raleigh**
Hallmark Electronics, (919) 832-4465
NM **Albuquerque**
Century Electronics, (505) 292-2700
NY **Binghamton**
Harvey Electronics, (607) 748-8211
Hauppage
Harvey Electronics, (516) 921-8700
Woodbury
Harvey Electronics, (516) 921-8700
OH **Cleveland**
Pioneer Electronics, (216) 587-3600
Dayton
Pioneer Electronics, (513) 236-9900
PA **Huntington Valley**
Hallmark Electronics, (215) 355-7300
Pittsburgh
Pioneer Electronics, (412) 782-2300
TX **Dallas**
Sterling Electronics, (214) 357-9131
Houston
Sterling Electronics, (713) 627-9800
WA **Seattle**
Intermark Electronics, (216) 767-3160
Can **Montreal, Quebec**
Cesco Electronics, (514) 735-5511
Toronto, Ontario
Westburne Electronics, (416) 787-2431
Vancouver, B.C.
Bowtek Electronics, Ltd. (604) 736-1141

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Ragen Semiconductor

Ragen Semiconductor
53 South Jefferson Road
Whippany, New Jersey 07981
(201) 887-4141
Information:
Oleg Burlak

Raytheon Semiconductor

Raytheon Semiconductor
350 Ellis St.
Mt. View, California 94042
(415) 968-9211
TWX: (910) 379-6481
Specific Product Information:
Linear ..... Dave Perry
Digital ..... Ray Solis
Discrete ..... Larry Collins
Hybrid ICs ..... Tom Cate
Microprocessors ..... Paul Sullivan
Price and delivery:
Local Field Sales Office
Place an order:
Local Field Sales Office
Follow-up an order:
Customer Service

Sales Offices & Representatives

AZ **Scottsdale**
SemperFi Sales Co., (602) 991-9197
CA **Irvine**
Raytheon Semiconductor, (714) 833-9042
Sunnyvale
Mission Marketing, (408) 732-9611
Mountain View
Raytheon Semiconductor, (415) 969-3475
CO **Denver**
Barnhill Five, (303) 426-0222
FL **Largo**
Perrott Assoc., (813) 585-3327
Fort Lauderdale
Perrott Assoc., (305) 792-2211
Orlando
Perrott Assoc., (305) 275-1132
IL **Chicago**
Carlson Electronic Sales, (312) 774-9022
Des Plaines
Raytheon Semiconductor, (312) 297-5540
KS **Overland Park**
Electri-Rep., (913) 649-2168
MA **Burlington**
Raytheon Semiconductor, (617) 272-8500
Lexington
Circuit Sales Co., (617) 861-0567
MI **Farmington**
Miltimore Sales, Inc., (313) 476-2446
MN **Bloomington**
Electronic Sales Agency, (612) 884-8291
Minneapolis
Raytheon Semiconductor, (612) 920-7935
MO **St. Louis**
Kebco, (314) 569-2660
NJ **Pennsauken**
Raytheon Semiconductor, (609) 663-4066
NY **Baldwin (NY Metro. Area)**
R.O.M.E. Inc., (516) 623-3344
Melville
Raytheon Semiconductor, (516) 420-0700
Syracuse
T. Squared Co. Inc., (315) 463-8592
Pittsford
T. Squared Co., Inc., (716) 381-2551
WA **Bellevue**
Northwest Marketing (206) 455-5846
WI **Milwaukee**
Carlson Electronic Sales, (414) 476-2790
Can **Massachusetts Office**
Intl **Germany, Munich**
Raytheon Halbleiter GmbH, 089/539-693
Intl **Japan, Tokyo**
New Japan Radio Co., Ltd., Tel: (591) 3451
Intl **Switzerland, Zurich**
Transistor AG Raytheon, Tel: 01 625-611
Intl **All Other Overseas Areas**
Lexington, Mass
Raytheon Co., International Tel: (617) 862-6600

Distributors

AL **Huntsville**
Hallmark Electronics, (205) 837-8700
AR **Fort Smith**
Carlton Bates, (501) 646-8201, (800) 362-9009
AZ **Phoenix**
Cramer Electronics, (602) 267-7321
Kierulff Electronics, (602) 273-7331
Sterling Electronics, (602) 258-4531
CA **Irvine**
Cramer/Los Angeles, (213) 771-8300 (714) 979-3000
Los Angeles
Kierulff Electronics, (213) 685-5511
Newport Beach
Semicomp, (714) 833-3070 (213) 581-7201
Palo Alto
Kierulff Electronics, (415) 968-6292
San Carlos
Sterling Electronics, (415) 592-2353
San Diego
Cramer/San Diego, (714) 565-1881
Intermark Electronics, (714) 279-5200
Kierulff Electronics, (714) 278-2112
Semicomp, (714) 560-0373
Santa Ana
Intermark Electronics, (714) 540-1322, (213) 436-5275
Sunnyvale
Bell Industries, (408) 734-8570
Cramer/San Francisco, (408) 739-3011
Intermark Electronics, (408) 738-1111
Semicomp, (408) 736-2330
CO **Denver**
Cramer/Denver, (303) 758-2100
Wheatridge
Century Electronics, (303) 424-1985
CT **North Haven**
Cramer/Connecticut, (203) 239-5641
FL **Clearwater**
Diplomat/Southland, (813) 443-4514
Hollywood
Cramer/EW Hollywood, (305) 923-8181
Orlando
Cramer/EW Orlando, (305) 894-1511
GA **Atlanta**
Cramer/EW Atlanta, (404) 448-9050
Lykes Electronics, (404) 355-2223
IL **Elk Grove Village**
Hallmark Electronics, (312) 437-8800
Diplomat/Lakeland, (312) 595-1000
Mt. Prospect
Cramer/Chicago, (312) 593-8230
IN **Indianapolis**
Graham Electronics Supply, Inc., (317) 635-5453
Advent Electronics, (317) 297-4910
MA **Billerica**
Kierulff Electronics, (617) 667-8331
Framingham
Future Electronics, (617) 879-0860, (800) 225-0380-Toll Free
Newton
Cramer Electronics, (617) 964-4000
Watertown
Sterling Electronics, (617) 926-9720
MD **Baltimore**
Radio Electric Service Company, (301) 823-0070
Technico, (301) 828-6416
Gaithersburg
Cramer/Washington, (301) 948-0110
Pioneer Washington Elect., (301) 948-0710
MI **Farmington**
Advent Elect., (313) 477-1650
Diplomat/Northland, (313) 477-3200
MN **Minneapolis**
Diplomat/Electronics Company, (612) 788-8601
Hallmark Electronics, (612) 884-9056
Stark Electronic Supply, (612) 332-1325
Edina
Cramer/Minnesota, (612) 835-7811
MO **Earth City**
Hallmark Electronics, (314) 291-5350
St. Louis
Diplomat/St. Louis, (314) 645-8550
NC **Winston Salem**
Cramer/EW Winston Salem, (919) 725-8711
NJ **Cherry Hill**
Cramer/Pennsylvania, (609) 424-5993
Hackensack
Components Plus, (201) 487-0565
Moonachie
Cramer Electronics, (201) 935-5600
Moorestown
Arrow/Angus, (609) 235-1900
NM **Albuquerque**
Century Electronics, (505) 292-2700
Cramer/New Mexico, (505) 265-5767
Kierulff Electronics, (505) 247-1055
Sterling Electronics, (505) 345-6601
NY **East Syracuse**
Cramer/Syracuse, (315) 437-6671
Elmsford
Zeus Components, Inc., (914) 592-4120
Hauppauge
Components Plus, (516) 231-9200
Cramer/Long Island, (516) 231-5600
Semiconductor Concepts, (516) 273-1234
New Hyde Park
Lafayette Industrial Elect., (516) 488-6600
Plainview
ACI Electronics Corp., (513) 293-6630
Rochester
Cramer/Rochester, (716) 275-0300
OH **Cleveland**
Cramer/Cleveland, (216) 248-8400
Columbus
Reptron/Ohio, (614) 443-0231
Dayton
Diplomat/Ohio, (513) 228-1080
OK **Tulsa**
Component Specialties, (918) 664-2820
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RCA Solid State Division

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RCA Purchasing Co., Tel: 581-2311
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Intl **Netherlands, Amsterdam**
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Intl **South Africa, Pretoria**
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Intl **Sweden, Stockholm**
Nordisk Elektronik AB, Tel: (08) 24 83 40

Intl **Switzerland**
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Herbert Controls & Instruments, Ltd., Tel: 3841 Std Code 04626

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Microelectronic Device Division
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Anaheim, California 92803
(714) 632-3729

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Sanken Electric Co.

Sanken Electric Company
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(617) 969-1610
Telex: 92-2482
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Application engineering:
Product Marketing ..... Umberto Broggi
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All Information:
Bob Zolkowski

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Signetics Corporation
811 East Arques Avenue
Sunnyvale, California 94086
(408) 739-7700
TWX: (910) 339-9283
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TTL ..... Ext. 3658
ECL ..... Ext. 2658

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Application engineering:
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Analog
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Silicon General

Silicon General, Inc.
7382 Bolsa Ave.
Westminister, California 92683
(714) 892-5531
TWX: (910) 596-1804

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Westates Electronics Corp., (213) 341-4411
San Diego
Total Electronics Corp., (714) 224-3291
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Intermark, (408) 738-1111
CO **Wheatridge**
Century Electronics, (303) 424-1985
CT **Westport**
Components Plus, (203) 226-4731
FL **Clearwater**
Southland Elec., (813) 443-4514
Pompano Beach
Zeus Components, (305) 942-4312
IL **Westmont**
Bodelle Company, (312) 323-9670
MA **Lexington**
R & D Electronics, (617) 861-9200
MD **Savage**
Pyttronic Industries, (301) 792-7000
NJ **Cherry Hill**
Milgray/Delaware, (609) 424-1300
Wallington
Tory Sales, (201) 935-3531
NM **Albuquerque**
Century Electronics, (505) 292-2700
Kierluff Elec., (505) 247-1055
NY **Binghamton**
Federal Electronics, (607) 748-8211
Freeport
Milgray Electronics, (516) 546-6000
Syracuse
Hamilton/Avnet, (315) 437-2641
Woodbury
Diplomat Elec. Corp., (516) 921-9373
TX **Dallas**
Quality Components, (214) 387-4949, (713) 789-9320
UT **Salt Lake City**
Century Electronics, (801) 487-8551
Intl **Austria**
Kinsington, London
G.E. Ectronics (London) Ltd., Tel: 01-7270711/3 & 5008

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Intl **Germany, Munchen**
Selectron GmbH, Tel: 591053
Intl **Netherlands, Scheveningen**
MCA Tronixs, Tel: 70/548890
Intl **Spain, Barcelona**
EXSA Control de Procesos, Tel: 2181208
Intl **Sweden, Vallingby**
Svensk Tele Industri AB, Tel: 890435
Intl **Switzerland**
Kinsington, London
G.E. Ectronics (London) Ltd., Tel: 01-7270711/3 & 5008
Intl **United Kingdom**
Kinsington, London
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Teledyne Philbrick

Teledyne Philbrick
Allied Drive at Route 128
Dedham, Massachusetts 02026
(617) 329-1600
TWX: (710) 348-6726

Sales Offices & Representatives

CA **Los Angeles**
Western Sales Office, (213) 478-0211
MA **Dedham**
Eastern Sales Office, (617) 329-1600
MN **Brooklyn Park**
Midwestern Sales Office, (612) 561-3931

Teledyne Semiconductor

Teledyne Semiconductor
1300 Terra Bella Avenue
Mountain View, California 94043
(415) 968-9241
TWX: (910) 379-6494
Specific product information:
Digital Marketing
Linear Marketing
Application engineering:
See Product Information
Literature:
Literature Center
Price and delivery:
See Product Information
Place an order:
Local Field Sales Office or Order Entry
Follow-up an order:
Customer Service for (Product)
All other information:
Marketing Services

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EMA, (205) 837-6061
AZ **Tempe**
Sedco Sales, (602) 968-7791
CA **Escondido**
Cirolia Electronic Sales, (714) 743-3015
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Teledyne Semiconductor, (213) 826-6639
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Teledyne Semiconductor, (415) 965-1455
Redwood City
James S. Heaton Co., Inc., (415) 369-4671
CO **Wheat Ridge**
Waugaman Assoc., (303) 423-1020
CT **East Norwalk**
Mill-Bern Assoc., (203) 838-1493
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Hutto Hawkins Peregoy, (305) 831-2474
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Hutto Hawkins Peregoy, (305) 943-9593
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Penzner-Mankus Corp., (319) 362-9177
IL **Des Plaines**
Teledyne Semiconductor, (312) 299-6196
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Gassner & Clark Co., (312) 345-4245
IN **Fort Wayne**
The Given Corp, G & D Electronic Sales, (219) 432-5585
KS **Overland Park**
Penzner-Mankus Corp., (913) 381-0004
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Penzner-Mankus Corp., (316) 264-2662
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Dynasel Assoc., (617) 890-6777
MD **Baltimore**
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Teledyne Semiconductor, (603) 893-9551
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Neal Bear Corp., Bear Marketing, (216) 659-3131
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Evans-McDowell Assoc., (713) 783-2900
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PR **Santurce**
E. Franceschini Assoc., (809) 726-0225
Can **St. Laurent, P.Q.**
Vitel Electronics, (514) 331-7393
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Vitel Electronics, (416) 622-6300
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Teledyne Semiconductor, (Tel: (44) 01-897-2503
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Teledyne Semiconductor, Tel: 3-240122
Intl **Japan, Tokyo**
Teledyne Semiconductor, Tel: 03-405-5738
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Teledyne Semiconductor, Tel: 2582811
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Teledyne Semiconductor, Tel: 7741-5066

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Electronic Supply, (714) 683-8110
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Intermark Electronics, (714) 279-5200
Kierulff Electronics Co., (714) 278-2122
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Intermark Electronics, (714) 540-1322
San Carlos
Sterling Electronics, (415) 592-2353
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Semiconductor Concepts, (213) 884-4560
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Century Electronics, (303) 424-1985
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Bell Industries, (312) 965-7500
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Framingham
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Rep-tron, (313) 525-2700
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Pyttronic Industries, (215) 643-2850
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Component Specialties, (214) 357-4576
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Component Specialties, (713) 771-7237
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R.A.E., (604) 687-2621
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Austronic Engineering Labs, Pty, Ltd., Tel: (03) 387-1477
Prospect
A.J. Ferguson (Adelaide) Pty, Ltd., Tel: 269-1244
Intl **Belgium, Brussels**
Sobelab Electronics S.A., Tel: 673-9055
Intl **Denmark, Herlev**
A/S Nordisk Elektronik, Tel: (45) (1) 969596
Intl **Finland, Helsinki**
Yleiselektronikka Oy, Tel: 578922
Intl **France, Sevres**
Tekelec Airtronic, Tel: (8) 626-0235

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Theo Henskes, Tel: (49) (511) 440213
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Omni Ray GmbH, Tel: (49) (2153) 4548
Ottobrunn
Hot Electronic
Vertreibs GmbH & Co. KG.
Unterhaching
Metronik GmbH, Tel: (49) (811) 615560
Intl **Holland, Barneveld**
Ritro Electronics N.V., Tel: 03420 5041
Intl **Iran, Tehran**
Oversun Co., Tel: 40719
Intl **Israel, Tel Aviv**
STG International Ltd., Tel: (10) 53459
Intl **Italy**
Milan
Mesa, S.P.A., Tel: (39) (2) 3491040
Tekelec Airtronic S.P.A., Tel: (39) (2) 738 56 74
Intl **Japan**
Tokyo
KH Electronics Corp., Tel: 584-6395, 584-7111
O.S. Seiki Company, Ltd., Tel: 255-6051
Takachiho Koheki Company, Tel: 263-3211
Teijin Advance Products Corp., Tel: (506) 4670-3
Towa Denshi Company, Ltd., Tel: 0422-31-3211
Intl **Norway, Oslo**
Nordisk Elektronik, Tel: (47) (2) 55-38-93
Intl **Singapore, Singapore**
Techco (Private) Ltd., Tel: 2588663 2587390
Intl **So. Africa, Johannesburg**
Impectron Pty., Ltd., Tel: 22-1386-28-7856
Intl **Spain, Madrid**
Payma S.A., Tel: (34) (1) 215-3941
Intl **Sweden, Stockholm**
Nordisk Electronik AB, Tel: (46) (8) 24-83-40
Intl **Switzerland**
Zurich
Omni Ray AG., Tel: (41) (57) 54665
Mutshellen
W. Storiz A,G,
Intl **United Kingdom**
Hitchin
Double R. Electronics
Royal Tunbridge Wells
Digital Devices, Ltd., Tel: (0892) 37977/9
Slough
G.D.S. Sales, Ltd., Slough
Macro-Marketing Ltd., Tel: (44) (753) 35444

Telefunken

AEG-Telefunken
570 Sylvan Avenue
Englewood Cliffs, New Jersey 07632
(201) 568-8570
Telex: 135497
Specific product information:
ICs ..... Electronics Group

Texas Instruments

Texas Instruments Incorporated
Semiconductor Group
P.O. Box 5012
Dallas, Texas, 75222
(214) 238-2011
TWX: (910) 867-4702
Specific product information:
Digital Circuits
Houston, Texas (713) 494-5115 ..... ext 2734
MOS
Houston, Texas (713) 494-5115 ..... ext 2821
Special Products
Dallas, Texas
Low Power
LowPower Schottky
CMOS (214) 238-2011 ..... ext 4841
Consumer Circuits
Lubbock Texas (806) 762'8831 ..... ext 51
Linear Circuits
Dallas, Texas (214) 238-2011 ..... ext 3865
Advanced Circuits
ECL
Sherman, Texas (214) 893-5166 ..... ext 303

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AZ **Phoenix**
Sales Office, (602) 24913138
CA **El Segundo**
Sales Office (213) 973-2571
San Diego
Sales Office, (714) 279-2622
Sunnyvale
Sales Office, (408) 732-1840
CO **Denver**
Sales Office, (303) 751-1780
CT **Hamden**
Sales Office, (203) 281-0074
FL **Ft. Lauderdale**
Sales Office, (305) 733-3300
Winter Park
Sales Office (305) 644-3535
IL **Glenview**
Sales Office, (312) 729-5710
IN **Ft. Wayne**
Sales Office, (219) 484-0606
Indianapolis
Sales Office, (317) 248-8555
MA **Waltham**
Sales Office, (617) 890-7400
MI **Southfield**
Sales Office, (313) 353-0830
MN **Edina**
Sales Office, (612) 835-2900
MO **Independence**
Sales Office (816) 836-2676
NC **Charlotte**
Sales Office (704) 372-8780
NJ **Clark**
Sales Office, (201) 574-9800
NM **Albuquerque**
Sales Office, (505) 265-8491
NY **East Syracuse**
Sales Office, (315) 463-9291
Endicott
Sales Office, (607) 785-9987
Fishkill
Sales Office, (914) 896-6793
Melville
Sales Office (516) 293-2560
Rochester
Sales Office, (716) 461-1800
OH **Cleveland**
Sales Office (219) 464-2990
Dayton
Sales Office, (513) 253-3121
OR **Beaverton**
Sales Office, (503) 643-6759
PA **Ft. Washington**
Sales Office, (215) 643-6450
TX **Dallas**
Sales Office, (214) 238-6805
Govt. Sales Office (219) 235-4881
International Sales Office (214) 238-2616
Houston
Sales Office, (713) 777-4891
VA **Arlington**
Sales Office, (703) 525-0336
Richmond
Sales Office, (804) 320-3820
WA **Bellevue**
Sales Office, (206) 455-3480
Can **Montreal, P.Q.**
Sales Office, (518) 341-3232
Toronto, Ont.
Sales Office, (716) 856-4453

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Hallmark Electronics, (205) 539-0691
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R.V. Weatherford, (602) 272-7144
CA **Anaheim**
R.V. Weatherford, (714) 633-9633
El Sugundo
TI Supply Company, (213) 973-2571
Glendale
R.V. Weatherford Co., (213) 849-3451
Goleta
Radio Product Sales, (805) 964-6823
Inglewood
Time Electronics, (213) 649-6900
Irvine
Cramer/Los Angeles, (714) 979-3000
Los Angeles
Kierulff Electronics, (213) 685-5511
Radio Product Sales, (213) 748-1271
Mountain View
Time Electronics, (415) 965-8000
Palo Alto
Kierulff Electronics, (415) 968-6292
Pomona
R.V. Weatherford Co., (714) 623-1261
San Diego
Cramer/San Diego, (714) 565-1881
Kierulff Electronics, (714) 278-2112
Radio Product Sales, (714) 292-5611
R.V. Weatherford, (714) 278-7400
Sunnyvale
Cramer/San Francisco, (408) 739-3011
G.S. Marshall, (408) 732-1100
TI Supply Company, (408) 732-5555
Woodland Hills
Semiconductor Concepts, (213) 884-4560
CO **Denver**
Cramer/Denver, (303) 758-2100
Kierulff Electronics, (303) 371-6500
CT **Hamden**
Arrow Electronics, (203) 248-3801
North Haven
Cramer/Connecticut, (203) 239-5641
Orange
Milgray/Connecticut, (203) 795-0714
FL **Ft. Lauderdale**
Arrow Electronics, (305) 971-9280
Hollywood
Cramer/EW Hollywood, (305) 923-8181
Orlando
Cramer/EW Orlando, (305) 894-1511
Hallmark Electronics, (305) 855-4020
GA **Atlanta**
Cramer/EW Atlanta, (404) 448-9050
IA **Cedar Rapids**
DEECO, Inc., (319) 365-7551
IL **Arlington Heights**
TI Supply Company, (312) 593-7660
Chicago
Newark Electronics Corp., (312) 638-4411
Semiconductor Specialists, (312) 279-1000
Mt. Prospect
Cramer/Chicago, (312) 593-8230
IN **Indianapolis**
Graham Electronics, (317) 634-8202
MA **Billerica**
Kierulff Electronics, (617) 667-8331
Newton
Cramer Electronics, (617) 969-7700
Waltham
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MD **Baltimore**
Arrow Electronics, (202) 737-1700
Columbia
Technico Inc., (301) 461-2200
Gaithersburg
Kierulff Electronics, (301) 948-0250
Hyattsville
Milgray/Washington, (301) 864-1111
MI **Detroit**
Newark Electronics, (313) 967-0600
Wyoming
Newark Electronics, (616) 241-6681
MN **Bloomington**
Arrow Electronics, (612) 888-5522
Edina
Cramer/Minnesota, (612) 835-7811
Minneapolis
Semiconductor Specialists, (612) 854-8841
MO **Hazelwood**
Semiconductor Specialists, (314) 731-2400
Kansas City
LCOMP-Kansas City, (816) 221-2400
Semiconductor Specialists, (816) 452-3900
St. Louis
LCOMP-St. Louis, (314) 647-5505
NC **Raleigh**
Hallmark Electronics, (919) 832-4465
Winston-Salem
Cramer/EW Winston-Salem, (919) 725-8711
NJ **Camden**
General Radio Supply Company, (609) 964-8560
Cherry Hill
Cramer/Pennsylvania, (215) 923-5950
Milgray/Delware Valley, (609) 424-1300, (215) 228-2000
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TI Supply Company, (201) 382-6400
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Cramer/New Jersey, (201) 935-5600
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R.V. Weatherford, (505) 842-0863
NY **East Syracuse**
Cramer/Syracuse, (315) 437-6671
Farmingdale
Arrow Electronics, (516) 694-6800
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Arrow Electronics, (914) 896-7530
Freeport
Milgray Electronics, (516) 546-6000
Hauppage
Cramer/Long Island, (516) 231-5600
Rochester
Cramer/Rochester, (716) 275-0300
Rochester Radio Supply Co., Inc., (716) 454-7800
OH **Cleveland**
Arrow Electronics, (216) 464-2000
Cramer/Cleveland, (216) 248-8400
Dayton
ESCO Electronics, (513) 226-1133
Kettering
Arrow Electronics, (513) 253-9176
OK **Tulsa**
TI Supply Company, (918) 437-4555
OR **Portland**
Almac-Stroum Electronics, (503) 292-3534
TX **Dallas**
TI Supply Company, (214) 238-6823
Houston
Harrison Equipment Company, (713) 652-4700
R.V. Weatherford Company, (713) 688-7406
TI Supply Company, (713) 777-6011
UT **Salt Lake City**
Standard Supply Company, (801) 486-3371
WA **Seattle**
Almac-Stroum Electronics, (206) 763-2300
Kierulff Electronics, (206) 763-1550
WI **New Berlin**
Arrow Electronics, (414) 2801
Wauwatosa
Semiconductor Specialists, (414) 257-1330
Can **Calgary**
Canadian Electronics, Ltd., (403) 287-1800
Downsview
CESCO Electronics, Ltd., (416) 661-9222
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Canadian Electronics, Ltd., (403) 452-9393
Montreal
CESCO Electronics, Ltd., (514) 735-5511
Future Electronics, (514) 735-5775
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CESCO Electronics, Ltd., (613) 729-5118
Future Electronics, (613) 232-7757
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CESCO Electronics, Ltd., (418) 524-4641
Rexdale
Future Electronics, (416) 677-7820
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Canadian Electronics, Ltd., (604) 324-7911
Future Electronics, (604) 261-1355
Winnipeg
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Melbourne
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Intl **Austria, Vienna**
TRANSISTOR Vertriebsges, GmbH, Tel: 0222/82 94 51
Intl **Belgium**
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Avi-Elec, Tel: 2/733 96 00
Deurne
Greday Electronics, Tel: 31/25 19 25
Intl **Denmark, Herlev**
TI Supply, Tel: 91-74 00
Intl **Finland, Helsinki**
TI Supply, Tel: 408 300
Intl **France**
Lagarde
Sofer, Tel: 94-27 16 10
Le Plessis Robinson
TISCO, Tel: 1-630 23 43
Lyon
Radiolex, Tel: 78-24 51 72
Tekelec, Tel: 78-74 37 40
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Tekelec, Tel: 91-47 22 20
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Fachet, Tel: 87-68 88 63
Meylan
TISCO, Tl: 76-90 45 74
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P.E.P., Tel: 1-735 33 20
Paris
Pariner, Tel: 1-878 65 55
Radio Voltaire, Tel: 1-357 50 11
Rennes
Tekelec, Tel: 99-50 62 35
Rungis
Electronique MS, Tel: 1-686 74 25
Roubaix
Eltec, Tel: 20-70 56 19
Sevres
Tekelec, Tel: 1-626 02 35
Strasbourg
Electronique MS, Tel: 88-32 88 32
Tarbes
Tarbelec, Tel: 62-93 10 82
Intl **Germany**
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Schiffers Elektronik, Tel: 0241/3 05 53
Berlin
TISCO, 030-74 44 041
Essen
TISCO, 0201-20 916
Frankfurt a.Main
Spoerle Electronic, Tel: 06103/6 20 31-38
Frankfurt-Griesham
TISCO, Tel: 0611-39 90 6
Gottingen
Retron GmbH, Tel: 0551-6 40 07
Hamburg
TISCO, Tel: 040-22 96 478
Walter Kluxen, Tel: 040/2 48 91
Hannover
TISCO, Tel: 0511-55 60 41
Munchen
Celdis GmbH, Tel: 089/59 91-1
Neumuller GmbH, Tl: 089/59 91-1
TISCO, Tel: 089/32 50 11
Nurnberg
Celdis GmbH, Tl: 0911/20 90 10
Schwieberdingen
Elkose, Tel: 07150/31041
Sprendlingen/FFm
Spoerle Electronic, Tel: 06103/604-1
Stutthard
TISCO, 0711/54 70 01
Toulouse
Electron, Tl: 61-62 82 85
Tekelec, Tl: 61-40 24 90
TISCO, Tel: 61-80 64 70
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Firenze
Paoletti Fer, Tel: 055/29 45 74
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Roma
Cramer Italia, Tel: 06/51 39 387
SFERA, Tel: 06/839 31 72
Torino
Carter, Te: 011/59 25 12
FIRET, Te: 011/66 65 72
Tortoreto Lido/Teramo
Do Dominicus, Tl: 095/37 20 45
Intl **Japan, Tokyo**
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Intl **Netherlands, Amsterdam-Schiphol**
TI Supply, Tel: 020-17 36 36
Intl **New Zealand, Auckland**
David J. Reid (N.Z.) Ltd., Tel: 492-189
Intl **Norway, Oslo**
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Intl **Puerto Rico, San German**
Cramer De Puerto Rico, Tl: (809) 892-2600
Intl **South Africa, Johannesburg**
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Intl **Sweden, Stockholm**
A.B. Gosta Backstrom, Te: 54 03 90
Intl **Switzerland, Zurich**
Fabrimex AG, 01/47 06 70
Intl **United Kingdom**
Birmingham
TI Supply, Tel: 021/734-5293
Derby
Quarndon Electronics Ltd., Tel: 0332-32651
Edinburgh
TI Supply, Tl: 031/229-1481
Enfield
Blueline Electronic Components, Tel: 01/366-6371
Harlow
Blueline Electronic Components, Tel: 0279-29588
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TI Supply, Te: 0753-33411
Portsmouth
SDS Components Ltd., Te: 0705-65311
Southampton
TI Supply, Tel: 0703-27741
Stockport
TI Supply, Tel: 061/432 0645

TMX

TMX, Inc
545 Fifth Avenue
New York, New York 10017
(212) 661-9400

Toshiba

Toshiba America
Chicago Office
5235 N. Elston Avenue
Chicago, Illinois 60630
(312) 545-5123

New York Office
280 Park Avenue
New York, New York 10017
(212) 557-0407

Main Office
Toshiba Semiconductor Division
1 Komukai-Toshiba-choo, Saiwai-ku
Kawasaki City, Kanagawa 210, Japan

TRW

TRW Electronic Systems Division
Space and Defense Systems
One Space Park
Redondo Beach, California 90278
(213) 536-1977

TRW Solid State Operations
301 West O Street
Ogallala, Nebraska 69153
(308) 284-3611
Product Information:
7400 Series ..... Ogallala, Nebraska (308) 284-3611
VLSI Devices Redondo Beach, California (213) 536-1977

Western Digital

Western Digital Corporation
3128 Red Hill Avenue
P.O. Box 2180
Newport Beach, California 92663
(714) 557-3550
TWX: (910) 595-1139
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(408) 446-4666

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Berlin
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ABBREVIATIONS OF COMPANY NAMES

AD	Analog Devices
AMD	Advanced Micro Devices
AMI	American Microsystems, Inc.
AMS	Advanced Memory Systems (Intersil)
Analogic	Analogic Corp.
Beckman	Beckman Instruments, Helipot Division
Burr-Brown	Burr-Brown Research
Cermetek	Cermetek
CMA	Consumer Microcircuits of America
Collins	Collins, Rockwell International
Data Gen	Data General
Datel	Datel Systems
DDC	Data Devices Corp.
EA	Electronic Arrays
EMM/Semi	EMM Semi, Div. of Electronic Memories & Magnetics
Essex	Essex International
Exar	Exar Integrated Systems
Fairchild	Fairchild Semiconductor Systems
Ferranti	Ferranti Electric
Fujitsu	Fujitsu
GI	General Instrument
Harris	Harris Semiconductor
Hitachi	Hitachi America, Ltd.
Hughes	Hughes Aircraft, MOS Division
Hybrid Sys	Hybrid Systems
IMI	International Microcircuits, Inc.
Intech	Intech/Function Modules
Intel	Intel
Interdesign	Interdesign
Intersil	Intersil
IPI	Integrated Photomatrix, Inc.
ITT	ITT Semiconductors
Lithic Sys	Lithic Systems
Litronix	Litronix
LSI Comp	LSI Computer Systems
Micro Comp	Micro Components
Micro Net	Micro Networks
Micropac	Micropac Industries
Micro Power	Micro Power Systems
Mitel	Mitel Semiconductor
Mitsubishi	Mitsubishi International
MMI	Monolithic Memories, Inc.
MOS	MOS Technology
Mostek	Mostek
Motorola	Motorola Semiconductor
National	National Semiconductor
NCR	National Cash Register, Microelectronics Div.
NEC	NEC Microcomputers
Nippon	Nippon Electric Co.
Nitron	Nitron
Nortec	Nortec Electronics
NPC	Nucleonic Products Co.
Panasonic	Panasonic, Matsushita Electric Corp.
Plessey	Plessey Semiconductors
PMC	Power Monolithics Co.
PMI	Precision Monolithics, Inc.
Ragen	Ragen Semiconductor
Raytheon	Raytheon Semiconductor
RCA	RCA Solid State Division
Reticon	Reticon
Rockwell	Rockwell, Microelectronic Div.
Sanken	Sanken Electric
SGS	SGS-ATES Semiconductor
Siemens	Siemens
Signetics	Signetics
Silicon G	Silicon General
Siliconix	Siliconix
SMC	SMC Microsystems Corp.
SMS	Scientific Micro
Solitron	Solitron Devices
Sprague	Sprague Electric Company
SSS	Solid State Scientific
SW	Stewart-Warner Microcircuits
Synertek	Synertek
Teledyne C	Teledyne Crystalonics
Teledyne P	Teledyne Philbrick
Teledyne S	Teledyne Semiconductor
Telefunken	AEG-Telefunken
TI	Texas Instruments
TMX	TMX
Toshiba	Toshiba
TRW	TRW
Western	Western Digital
Zilog	Zilog

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PRODUCT INDEX

This index shows the page and the line on that page of every device in the Master Selection Guide and the Application Note Directory. It is organized alphabetically by manufacturer and for each manufacturer, alpha-numerically by device. Bold face listings lead to data on important products which has been supplied for you by the manufacturers. If you want to determine which products are in the book from a given manufacturer, simply check the Product Index.

how to use the product index

The Product Index contains the same references as the Part Number Index, but in this case the listings are sorted by manufacturer.

As in the Part Number Index, the model numbers are sorted alpha-numerically from **left** to **right.** Here the manufacturer's prefixes are included so that devices with alphabetic prefixes appear before those without them (i.e., LM101 would be before 1101). Application note pages are indicated by a ¶ sign and data by a ★ sign. The numbers preceding the dash are the page numbers, while those following the dash indicate the location on the device on the page.

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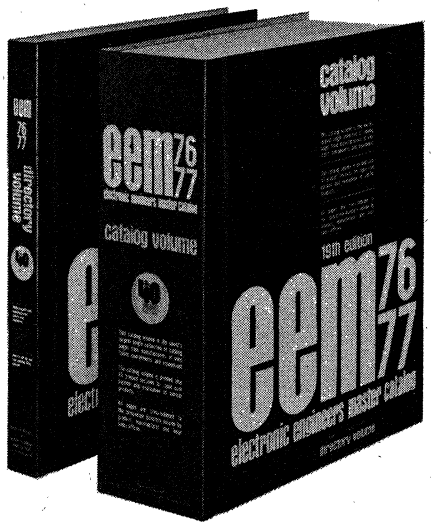

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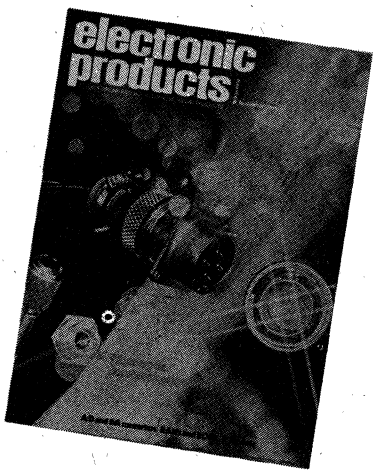

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ABBREVIATIONS OF COMPANY NAMES

AD	Analog Devices
AMD	Advanced Micro Devices
AMI	American Microsystems, Inc.
AMS	Advanced Memory Systems (Intersil)
Analogic	Analogic Corp.
Beckman	Beckman Instruments, Helipot Division
Burr-Brown	Burr-Brown Research
Cermetek	Cermetek
CMA	Consumer Microcircuits of America
Collins	Collins, Rockwell International
Data Gen	Data General
Datel	Datel Systems
DDC	Data Devices Corp.
EA	Electronic Arrays
EMM/Semi	EMM Semi, Div. of Electronic Memories & Magnetics
Essex	Essex International
Exar	Exar Integrated Systems
Fairchild	Fairchild Semiconductor Systems
Ferranti	Ferranti Electric
Fujitsu	Fujitsu
GI	General Instrument
Harris	Harris Semiconductor
Hitachi	Hitachi America, Ltd.
Hughes	Hughes Aircraft, MOS Division
Hybrid Sys	Hybrid Systems
IMI	International Microcircuits, Inc.
Intech	Intech/Function Modules
Intel	Intel
Interdesign	Interdesign
Intersil	Intersil
IPI	Integrated Photomatrix, Inc.
ITT	ITT Semiconductors
Lithic Sys	Lithic Systems
Litronix	Litronix
LSI Comp	LSI Computer Systems
Micro Comp	Micro Components
Micro Net	Micro Networks
Micropac	Micropac Industries
Micro Power	Micro Power Systems
Mitel	Mitel Semiconductor
Mitsubishi	Mitsubishi International
MMI	Monolithic Memories, Inc.
MOS	MOS Technology
Mostek	Mostek
Motorola	Motorola Semiconductor
National	National Semiconductor
NCR	National Cash Register, Microelectronics Div.
NEC	NEC Microcomputers
Nippon	Nippon Electric Co.
Nitron	Nitron
Nortec	Nortec Electronics
NPC	Nucleonic Products Co.
Panasonic	Panasonic, Matsushita Electric Corp.
Plessey	Plessey Semiconductors
PMC	Power Monolithics Co.
PMI	Precision Monolithics, Inc.
Ragen	Ragen Semiconductor
Raytheon	Raytheon Semiconductor
RCA	RCA Solid State Division
Reticon	Reticon
Rockwell	Rockwell, Microelectronic Div.
Sanken	Sanken Electric
SGS	SGS-ATES Semiconductor
Siemens	Siemens
Signetics	Signetics
Silicon G	Silicon General
Siliconix	Siliconix
SMC	SMC Microsystems Corp.
SMS	Scientific Micro
Solitron	Solitron Devices
Sprague	Sprague Electric Company
SSS	Solid State Scientific
SW	Stewart-Warner Microcircuits
Synertek	Synertek
Teledyne C	Teledyne Crystalonics
Teledyne P	Teledyne Philbrick
Teledyne S	Teledyne Semiconductor
Telefunken	AEG-Telefunken
TI	Texas Instruments
TMX	TMX
Toshiba	Toshiba
TRW	TRW
Western	Western Digital
Zilog	Zilog

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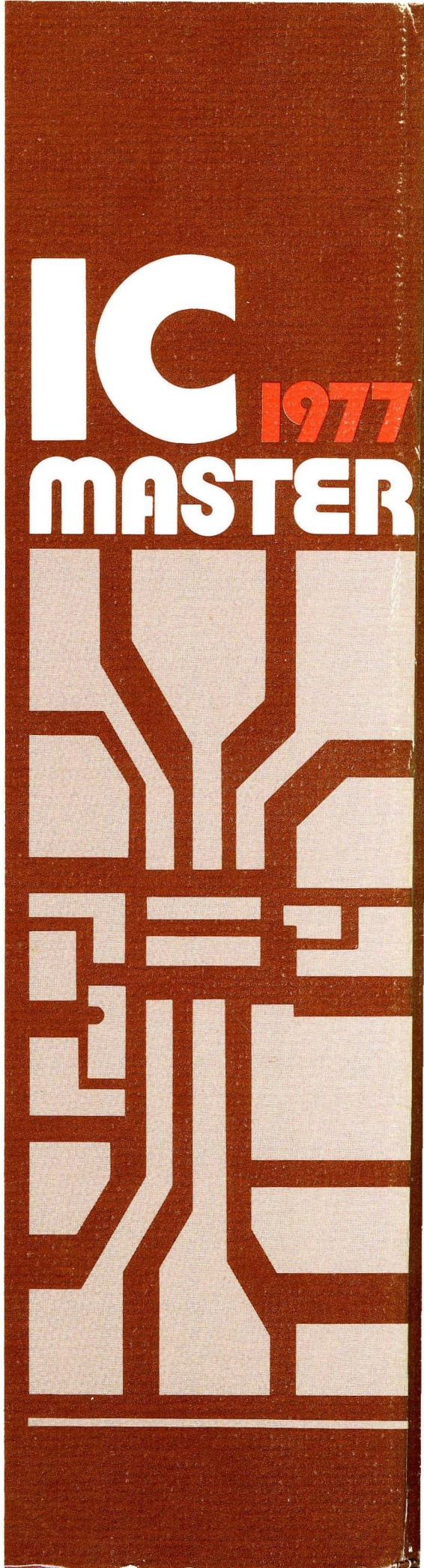

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